INSTRUCTION MANUAL

MODEL LC1201B

California INSTRUMENTS

Invertron® AC POWER EQUIPMENT

An affiliate of Amstar CORPORATION

California Instruments

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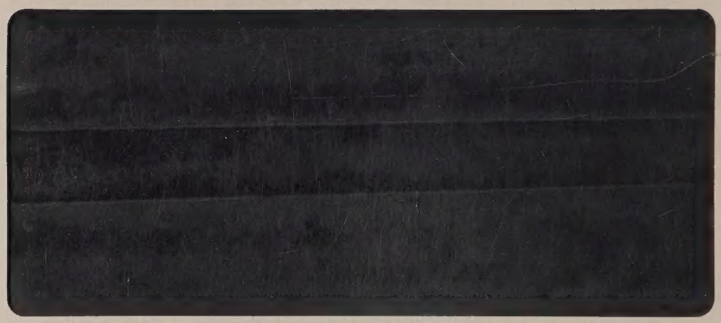

California INSTRUMENTS

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Invertron®

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ASSEMBLY REFERENCE DESIGNATOR	DRAWING NUMBER	TITLE
None	E1120-400	UNIT ASSEMBLY
A1	E1120-700	UNIT P.C. ASSEMBLY
A1	E1120-070	UNIT SCHEMATIC
A2	C1120-704	P.C. ASSEMBLY
A2	C1120-078	P.C. ASSEMBLY

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SPECIFICATIONS

MODEL LC-1201B DYNAMIC LINE CORRECTOR

All specifications are tested in accordance with standard California Instruments test procedures.

INPUT CHARACTERISTICS:	
VOLTAGE: (selected by rear panel tap switch)	90 volts to 110 volts rms 103.5 volts to 126.5 volts rms 117 volts to 143 volts rms
FREQUENCY:	57 to 63 Hz
POWER:	2000 watts maximum
HARMONIC DISTORTION:	10 per cent maximum
ISOLATION:	100 dB common mode isolation. Low side of output line normally strapped to chassis, but may be floated to 300 volts rms.
OUTPUT CHARACTERISTICS:	
VOLTAGE:	115 volts rms ±0.15 per cent
VOLTAGE SETABILITY:	±0.01 per cent
VOLTAGE INSTABILITY:	±0.05 per cent for 24 hours under constant line, load and ambient temperature conditions.
POWER:	1200 VA from unity to ±.7 power factor; 6000 VA maximum instantaneous peak power.
CREST FACTOR:	3.5 to 1 maximum at rated power output.
HARMONIC DISTORTION:	0.2 per cent maximum.
LINE REGULATION:	0.025 per cent for a 10 volt incoming line change.
LOAD REGULATION:	0.025 per cent for a zero to full resistive load change. 0.05 per cent for a zero to full load change at ±0.7 power factor.
AMPLITUDE TEMPERATURE COEFFICIENT:	0.005 per cent per degree C maximum.

CYCLE-TO-CYCLE PEAK AMPLITUDE INSTABILITY:	±0.01 per cent for input line cycle-to-cycle phase stability of ±.18 degrees (typical power line)
LOAD CAPACITANCE:	5μF at zero power factor; 100μfd maximum at 0.1 power factor or greater.

TRANSIENT CHARACTERISTICS:

LINE: (with 10 per cent step change)	Output transient will not exceed 0.5 per cent peak amplitude and will fall to 0.05 per cent in less than 0.5 second.
LOAD: (zero to full load change)	Output transient will not exceed 0.5 per cent peak amplitude and will fall to 0.05 per cent in less than 0.5 second.
INPUT LINE TRANSIENT ATTENUATION:	Reduces 500 volt peak-to-peak 10 microsecond line transients to less than 0.5 volt peak-to-peak.
IMPULSE SETTLING TIME: (due to 1 ampere, 1 millisecond load pulse)	50 microseconds or less to 0.1 per cent of output voltage.
OVERLOAD RECOVERY TIME:	Automatically recovers in less than one cycle when overload is removed.
OVERLOAD INDICATION:	Front panel lamp illuminates when load is excessive. Raw AC power is applied to load during overload.
OVERLOAD PROTECTION:	Gross overload condition actuates front panel circuit breaker.

GENERAL:

FRONT PANEL METER:	Input voltage, output voltage and load current are monitored with a switchable 0-150 volt, 0-15 ampere meter. Meter accuracy is ±3 per cent of full scale for sinusoidal current flow.
AMBIENT TEMPERATURE:	0 to 55 degrees C
STORAGE TEMPERATURE:	-20 degrees C to +85 degrees C
COOLING:	A blower provides internal forced air circulation; air does not pass through the front panel.

DIMENSIONS:	19" W x 5 1/4" H x 20 1/2" D, (48.26cm W x 13.33cm H x 52.07cm D) for standard rack mounting.
NET WEIGHT:	75 pounds 34.02 Kg
SHIPPING WEIGHT:	80 pounds 36.29 Kg
FRONT PANEL FINISH:	Grey 26440 per Fed. Std. 595

GENERAL DESCRIPTION

1.1 INTRODUCTION

This instruction manual contains information on the application, installation, operation, calibration and maintenance of the California Instruments Model LC-1201B Dynamic AC Line Corrector. A detailed theory of operation is provided as an aid to maintenance personnel. Complete parts listing, schematics and component drawings are also supplied.

1.2 DESCRIPTION

The California Instruments Model LC-1201B Dynamic AC Line Corrector is illustrated in Figure 1. This unit is a highly reliable solid state power supply designed to produce precisely regulated, transient-free AC power. The California Instruments Model LC-1201B Dynamic AC Line Corrector accepts an AC input voltage with up to 10 per cent harmonic distortion and delivers a sine wave output voltage with less than 0.2 per cent distortion.

The dynamic line corrector will supply 115 volts rms at 1200 VA output with a load power factor between 1.0 and 0.7 either lag or lead.

The Model LC-1201B Dynamic Line Corrector has been completely designed with silicon semiconductors utilizing conservative derating techniques to provide years of dependable service.

1.3 EQUIPMENT SUPPLIED

The California Instruments Model LC-1201B Dynamic AC Line Corrector is normally shipped with an instruction manual.

1.4 ACCESSORY EQUIPMENT

The following equipment is available for use with the California Instruments Model LC-1201B Dynamic AC Line Corrector.

1.4.1 Zero Manufacturing Company Model C-300S rack slides. These rack slides may be bolted directly to the sides of the unit, if required.

WARNING

Voltages up to 125 VAC are available in certain sections of this line corrector. This equipment generates potentially lethal voltages.

DEATH

on contact may result if personnel fail to observe safety precautions. Do not touch electronic circuits when power is applied. Avoid contact with the primary power circuits and the 115 volt AC output circuit of the line corrector.

INSTALLATION AND OPERATION

2.1 UNPACKING

Each Model LC-1201B Dynamic AC Line Corrector is shipped in a cardboard container with protective inner packing. Do not destroy the packing container until the unit has been inspected for possible damage in shipment.

2.2 POWER REQUIREMENTS

The California Instruments Model LC-1201B Dynamic AC Line Corrector operates from the 60 Hz AC power line over the voltage range from 90 volts rms to 143 volts rms in three sub-ranges: 90 to 110 volts, 103.5 to 126.5 volts, and 117 to 143 volts. These sub-ranges are selected by a three position tap switch located at the rear of the line corrector. The unit is normally shipped with this tap switch set for a line voltage range from 103.5 volts to 126.5 volts.

Voltages above these limits in each specific range may damage the line corrector and/or cause excessive distortion to appear on the output of the line corrector. Voltages below these limits will cause excessive distortion to appear on the output of the line corrector.

The line corrector draws approximately 1800 watts from the AC line when it is operating under full load at nominal input line voltage.

2.3 CIRCUIT BREAKER PROTECTION

The Model LC-1201B Dynamic AC Line Corrector is protected by a single 20 ampere circuit breaker located on the front panel. Small overloads will not cause the circuit breaker to trip, but will cause a solid state overload circuit to be actuated. The line corrector will supply unregulated power during this time. Large overloads (several hundred watts or greater) will trip the circuit breaker and the output of the line corrector will go to zero.

2.4 ACCEPTANCE TEST PROCEDURE

Inspect the unit for any possible shipping damage immediately upon receipt. If any damage is evident, notify the carrier. Do not return an instrument to the factory without prior approval. If the unit appears to be in good condition, perform the following:

2.4.1 Connect the line cord of the line corrector to a 115 volt 60 Hz line in series with a 3 KW wattmeter. The wattmeter should indicate between 50 and 150 watts at 115 volt line with no load applied to the output of the line corrector.

2.4.2 Monitor the output voltage of the line corrector at the dual AC line connector at the rear of the unit. This voltage should be 115 volts rms ±0.15 per cent.

2.4.3 Connect a 1200 watt resistive heating coil (11.02 ohms) to the other half of the dual AC line connector at the rear of the unit. The wattmeter should indicate between 1800 and 2000 watts at full load. The output voltage should vary less than .025 per cent from no load to full load. If any problem appears to be evident, check that the input voltage to the line corrector is still 115 volts. If the input voltage has dropped to 103.5 volts under full load, then it is permissible for the output of the line corrector to vary 0.05 per cent as this now represents a test of both line and load simultaneously.

2.4.4 Place a 300 watt resistive load (44 ohms) in parallel with the 1200 watt load. The overload light should indicate and the line corrector should go out of regulation. When the 300 watt overload is removed, the line corrector should immediately return to normal operation. Potentiometer A1R96 may require a slight adjustment.

2.5 MECHANICAL INSTALLATION

The Model LC-1201B Dynamic AC Line Corrector is designed for rack mounting. The cooling fan at the rear of the line corrector must be free of any obstructions which would interfere with the flow of air. A three inch clearance should be maintained between the rear of the fan and the rear door of the mounting cabinet. Also the air intake holes on the sides and rear of the line corrector must not be obstructed.

2.6 INPUT POWER WIRING

The Model LC-1201B Dynamic AC Line Corrector will operate at input voltages of 90 to 143 volts in three ranges as described in Section 2.2 of this manual. The line corrector should be used with AC power lines with a capacity of 20 amperes or greater.

2.7 OUTPUT POWER WIRING

The regulated output appears at the dual two-blade AC power connector located at the rear of the line corrector. The unit is shipped for operation with the chassis connected with a grounding strap to the low side of the output. If isolated operation is required, remove this grounding strap to bring the output above chassis ground.

2.8 FRONT PANEL METER

The Model LC-1201B Dynamic AC Line Corrector is equipped with a front panel meter which can be switched from the front panel of the unit to read either the input voltage, the output voltage, or the output current of the line corrector. Full power output corresponds to a load current of 10.43 amperes. This meter has an accuracy of ±3% of full scale provided that the load current is sinusoidal.

2.9 INSTRUMENTATION LOADS

Most electronic equipment, which might be used as a load on the output of the line corrector, exhibits a high ratio of peak current to rms current. This ratio of peak current to rms current is called the crest factor. This crest factor varies from 1.414 for a pure resistive load to approximately 3.5 for a rectifier type load with a large capacitive input filter and a low source impedance. The Model LC-1201B Dynamic AC Line Corrector has been disigned for use with loads whose crest factor varies from 1.0 to 3.5 and therefore will provide excellent performance with 1200 VA of instrumentation load.

The typical instrumentation load with a single phase full wave rectifier and capacitive input filter exhibits a leading power factor of approximately 0.9. The Model LC-1201B Dynamic AC Line Corrector will supply full VA output with power factors from unity to ±0.7.

The line corrector has been designed utilizing both power active filter and standard L-C filter techniques to provide the maximum rejection to high frequency noise spikes as can be achieved by these methods. As a result, the pure capacitive load capability is limited to 5 microfarads. For practical cases, where a small series resistance can be tolerated (.1 power factor or greater) the unit will drive over 100 μfd of capacitive load.

2.10 FRONT PANEL CONTROLS

2.10 The circuit breaker, located on the front panel of the line corrector, is used to switch the unit "on". At this time the indicator located above this circuit breaker should glow.

The OVERLOAD indicator, located on the front panel, is used to indicate that the solid state overload protection circuit has been activated. Whenever this lamp is glowing, the line corrector is delivering unregulated power to the load. The OVERLOAD indicator is actuated for approximately 2 seconds when the power is first applied to the line corrector.

The OVERLOAD indicator operation is almost totally independent of the load crest factor, thereby providing a reliable indication of overload for all instrumentation loads.

WARNING

Voltages up to 125 VAC are available in certain sections of this line corrector. This equipment generates potentially lethal voltages.

DEATH

on contact may result if personnel fail to observe safety precautions. Do not touch electronic circuits when power is applied. Avoid contact with the primary power circuits and the 115 volt AC output circuit of the line corrector.

APPLICATION

3.1 GENERAL

The California Instruments Model LC-1201B Dynamic AC Line Corrector was designed to produce precisely regulated, transient-free AC power for applications where line transients may cause equipment failure, equipment inaccuracy or a loss of valuable data. For example:

a) Analog and digital data systems.

b) Digital computer applications.

c) Line power for laboratory standards.

d) Regulated power for RFI chambers, engineering laboratories, etc.

e) Applications where motor starting transients might interfere with sensitive electronic equipment.

f) Regulated power for x-ray applications.

g) Applications where SCR transients might interfere with sensitive electronic equipment.

h) Process control instrumentation.

In addition the following instruments are usually susceptible to line transients which are removed by the California Instruments Model LC-1201B Dynamic AC Line Corrector.

a) Spectrum analyzers.

b) Mini computers.

c) Gas chromatographs.

d) Nuclear scalers.

e) Infrared scanners.

f) Scanning electron microscopes.

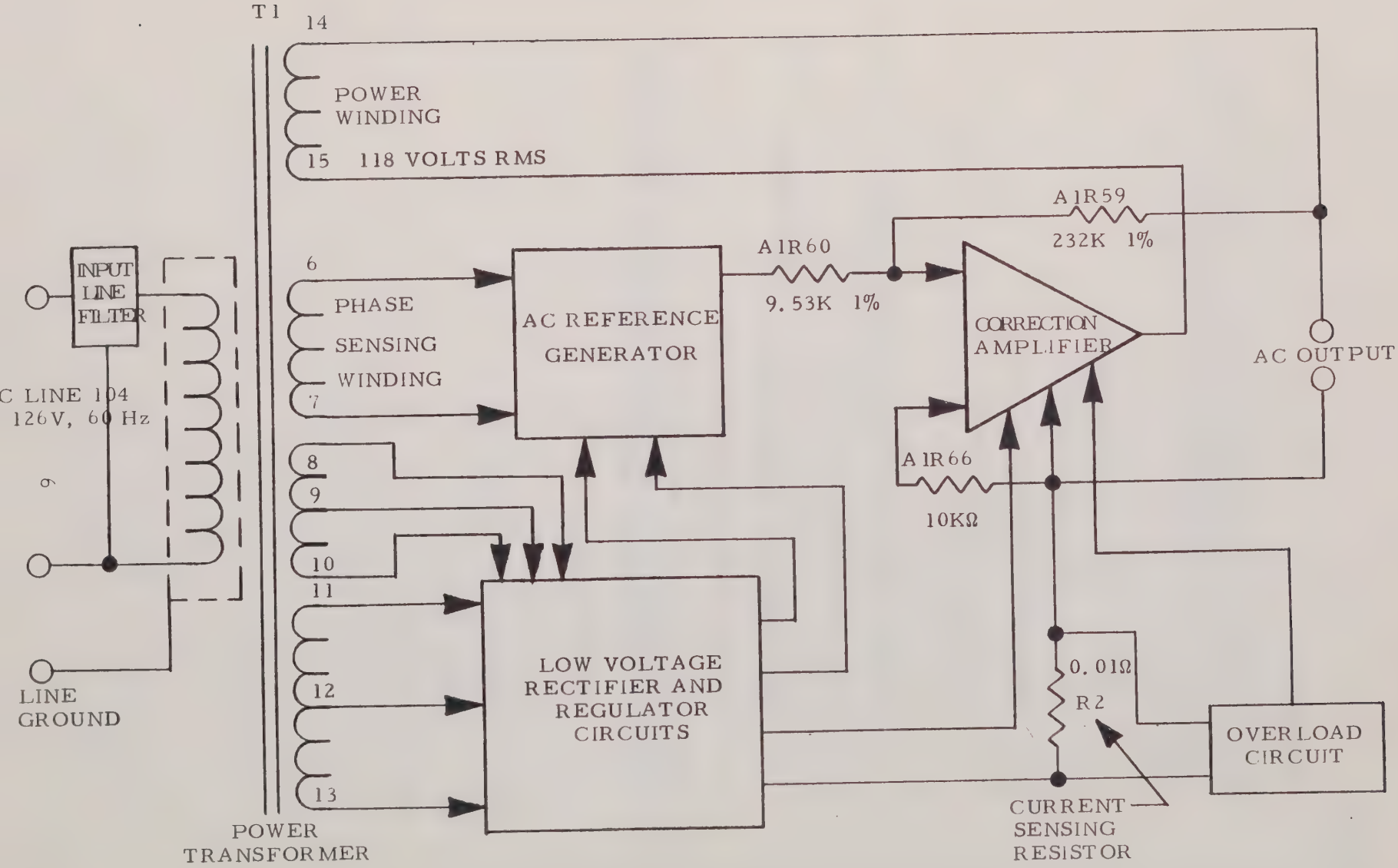


FIGURE 2. Block Diagram for Model LC-1201B Dynamic AC Line Corrector

THEORY OF OPERATION

4.1 GENERAL

The California Instruments Model LC-1201B Dynamic AC Line Corrector is a precision solid state power supply designed to produce precisely regulated, transient-free AC power while operating from the standard AC power line. A block diagram is given in figure 2 which illustrates the basic theory of operation. The raw AC input power is coupled to the system through an L-C line filter then to a box shielded power transformer. The L-C filter provides 40 dB of attenuation for incoming high frequency line transients and the transformer provides 100 dB of common-mode isolation between the raw input power and the regulated output power. The low coupling capacitance also reduces the level of RF noise and spikes coupled into the line corrector via the raw AC line.

The majority of the output power is delivered from the power winding contained on the power transformer. The power winding is connected in series with the output of the correction amplifier such that the algebraic sum of these two voltages is a pure, distortion-free sine wave.

The correction amplifier and power winding are enclosed by an operational feedback loop driven from an AC reference generator. This AC reference generator supplies a pure sine wave output which is phase locked to the 60 Hz AC line by means of a phase sensing winding on the power transformer. The distortion contained in this sine wave is very small (typically about 0.1 per cent) and amplitude regulation is excellent (typically about .01 per cent per 24 hours).

The overload section consists of a current sensing resistor and the associated overload circuitry. The output of this overload circuitry is used to drive clamping circuits in the correction amplifier. These clamp circuits protect the correction amplifier from excessive load currents and allow the unit to supply unregulated power while in the overload mode.

4.2 DETAILED CIRCUIT DESCRIPTION

A schematic diagram for the Model LC-1201B Dynamic AC Line Corrector is given in drawing number E1120-070. This drawing also gives typical voltage levels for all sections of the line corrector. All components mounted on the large printed circuit board, 1120-700, are designated as part of the A1 assembly. All other components are part of the top assembly.

4.2.1 REFERENCE GENERATOR

The reference generator is electrically divided into two basic sections: the amplitude control servo system and the phase control servo system. Figure 3 shows a block diagram of the reference generator.

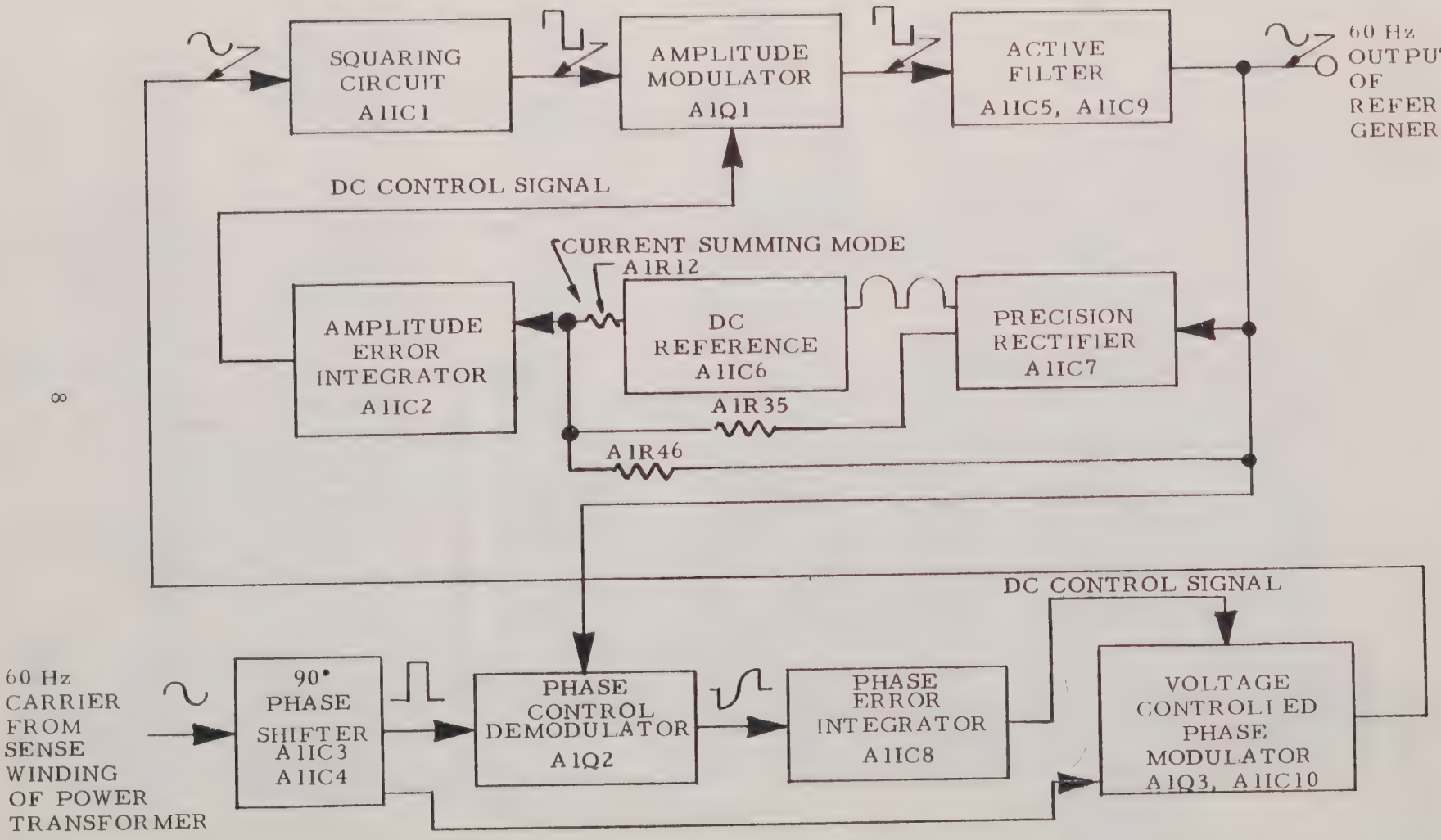


FIGURE 3. Block Diagram for Reference Generator

The amplitude control system consists of an active filter, a precision rectifier, a DC reference, an amplitude error integrator and the amplitude control modulator connected in a closed feedback loop. The difference between the precision rectifier output current and the DC reference output current is integrated and applied as the analog input to the modulator operating at a 60 Hz carrier frequency. The output of the modulator is used to drive an active filter which is resonant at 60 Hz. The output of this active filter is the desired output of the reference generator.

The phase control servo system consists of a 90° phase shifter, a phase controlled demodulator, a phase error integrator, and a voltage controlled phase modulator connected in a closed feedback loop. The difference between the phase controlled demodulator output and the AC reference is integrated and used to drive a voltage controlled phase modulator. This phase servo compensates for variations in the phase shift of the active filter with time, temperature and variations in the phase of the active filter with changes in the incoming AC line frequency.

4.2.1.1 AMPLITUDE CONTROL MODULATOR

The amplitude control modulator consists of switching transistor A1Q1 and associated components. The base of A1Q1 is driven by the phase corrected 60 Hz signal from the squaring amplifier A1IC1. The collector of A1Q1 is driven by the DC output of the amplitude error integrator through resistor A1R4. The square wave at the collector of A1Q1 is used to drive the first stage of the tuned amplifier and has an amplitude of 1.3 volts P-P.

If the gain of the active filter should vary due to changes in temperature, power line frequency, or aging, the amplitude control modulator A1Q1 will receive a change in the control input from the amplitude error integrator A1IC2. This, in turn, will allow the amplitude control modulator to correct the error and provide a constant AC reference output from A1IC9.

4.2.1.2 ACTIVE BANDPASS FILTER

The active bandpass filter consists of a pair of multiple feedback bandpass filters. These filters consist of integrated circuits A1IC5, A1IC9, and associated components. The input to the active filter is a square wave as generated by the amplitude modulator. This input signal is applied to A1IC5 pin 2 through resistor A1R20 and capacitor A1C9.

This first stage of the active filter is used to remove harmonics from the square wave and to provide a voltage gain of approximately 3.4 at 60 Hz (ratio of peak-to-peak square wave input to peak-to-peak sine wave output). The output of the first series resonant circuit contains a total harmonic distortion of approximately 3 per cent. This bandpass filter circuit is tuned to 64 Hz according to the procedure given in Section 5.3 of this instruction manual.

The second stage of the active filter is used to reduce the harmonic content in the 60 Hz sine wave to less than 0.15 per cent. This tuned circuit provides a voltage gain of approximately 3.2 at 60 Hz (ratio of peak-to-peak pure sine wave output to peak-to-peak distorted sine wave input). This bandpass filter circuit is tuned to 56 Hz according to the procedure given in Section 5.3 of this instruction manual.

The output from the active filter provides a 5.0 volt rms sine wave reference signal to the correction amplifier, the precision rectifier and the phase control demodulator.

4.2.1.3 PRECISION RECTIFIER

The precision rectifier consists of integrated circuit A1IC7 and associated components. Diode A1CR6 and A1CR7 are located in the feedback loop of this amplifier and are used to rectify the output of A1IC9. The positive one-half cycle output, available at the cathode of A1CR7, is applied to the input of the amplitude error integrator A1IC2 via current summing resistor A1R35. The output of A1IC9 is also applied to the input of the amplitude error integrator A1IC2, however, in the this case, via current summing resistor A1R46. These two currents add algabraically so as to provide a DC current into A1IC2 which is proportional to the AC output of A1IC9.

4.2.1.4 DC REFERENCE

The DC reference consists of integrated circuit A1IC6 and associated components and provides a stable -10 VDC output. Integrated circuit A1IC6 is used as a constant current source and drives temperature compensated zener diode A1CR4. The voltage divider consisting of resistors A1R16, A1R17, and A1R18 sets the DC output of the reference to -10V. Potentiometer A1R17 enables the output to varied ±6% to compensate for variations in the zener reference diode. The output of the DC reference is applied to the amplitude error integrator A1IC2 via current summing resistor A1R12.

4.2.1.5 AMPLITUDE ERROR INTEGRATOR

The amplitude error integrator consists of integrated circuit A1IC2 and associated components. The output of the amplitude error integrator is a +3.5 volt DC level (with .1 volt peak-to-peak 120 Hz ripple) which is used as the servo control voltage input to the amplitude control modulator A1Q1.

Capacitor A1C2 is used to reduce the ripple on the output of the amplitude error integrator A1IC2.

4.2.1.6 90 DEGREE PHASE SHIFT NETWORK

The 90 degree phase shift network consists of integrated circuits A1IC3, A1IC4 and associated components. The primary purpose of this circuit is to compensate for the 90 degree phase shift inherent in the phase control demodulator, A1Q2. The 90 degree phase shift network is driven from the sense winding on the power transformer T1 and provides a square wave output at pin 6 of A1IC4 whose zero crossing leads the zero crossing of the sense winding sine wave by 90 degrees.

Capacitor A1C6, connected in the feedback loop of A1IC3, provides the 90 degree phase lag. The output of A1IC3 is a sine wave whose amplitude is approximately 3 volts rms. This signal is applied to the non-inverting squaring amplifier A1IC4 which provides the required square wave output. Resistor A1R14, A1R23 and capacitor A1C10 provide a DC feedback loop for increased bias stability.

4.2.1.7 PHASE CONTROL DEMODULATOR

The phase control demodulator consists of transistor A1Q2 and associated components connected so as to form a shunt demodulator. This shunt demodulator connects the junction of resistors A1R29 in which the output of A1IC4 is a positive voltage.

4.2.1.8 PHASE ERROR INTEGRATOR

The phase error integrator consists of integrated circuit A1IC8 and associated components. Capacitors A1C12 and A1C31 are used to average the output of the phase control demodulator so as to obtain a DC level at pin 6 of A1IC8. This integrator output is a +1.5 VDC level (with 40 millivolts peak-to-peak 60 Hz ripple) which is applied as the control voltage to the voltage controlled phase shift circuit.

Phase adjustment potentiometer A1R140 allows the phase shift through the line corrector to be set to zero degrees.

4.2.1.9 VOLTAGE CONTROLLED PHASE SHIFT CIRCUIT

The voltage controlled phase shift circuit consists of integrated circuit A1IC10, Mosfet transistor A1Q3 and related components. The DC voltage from the phase error integrator is applied to the gate of A1Q3 where it acts so as to change the source to drain resistance of A1Q3, thereby changing the phase angle of the 60 Hz carrier at A1IC10 pin 6. As the source to drain resistance increases, the phase shift through A1IC10 decreases toward zero degrees. Potentiometer A1R58 is used to adjust the DC component of the A1IC10 output to 0 VDC.

4.2.2 CORRECTION AMPLIFIER

The correction amplifier is a direct coupled DC amplifier with an operational feedback loop. The closed loop frequency response of this amplifier extends from DC to beyond 200 KHz.

Electrically, the correction amplifier is split up into three sections. These are: a preamplifier, a power amplifier and the overload circuits.

4.2.2.1 PREAMPLIFIER

The preamplifier section of the correction amplifier consists of transistors A1Q6-A through A1Q6-E, ApQ7, A1Q8, and associated components in a direct coupled differential circuit configuration.

The input to the preamplifier, at the base of A1Q6-D, is obtained from the difference between the reference signal and the line corrector output as obtained at the junction of resistors A1R59 and A1R60. Potentiometer A1R56 is used to set the line corrector output to exactly 115 volts rms.

The input stage of the preamplifier consists of A1Q6-D, A1Q6-E and associated components connected as a differential amplifier. This stage provides a voltage gain of approximately 50 at DC. Capacitor A1C22 and resistor A1R70 provide a high frequency step roll off circuit starting at 800 Hz and continuing to 40 KHz. The gain of the first stage is approximately 1.0 at 40 KHz. Potentiometer A1R64 is used to set the DC output of the line corrector to zero volts ±20 millivolts DC. Transistor A1Q6-C is used as a zener diode and along with A1R63 sets the DC bias current in the first stage to approximately 100 microamperes per side.

The second stage of the preamplifier consists of transistors A1Q6-A, A1Q6-B and associated components connected as a differential amplifier. This stage provides a differential voltage gain of approximately 10 at DC. Resistor A1R78 sets the DC bias current in the second stage to approximately 1.0 milliamperes per side.

The third stage of the preamplifier consists of transistors A1Q7, A1Q8 and associated components connected as a differential amplifier. This stage provides a gain of approximately 6.0 at DC. Resistor A1R84 sets the DC bias current in the third stage to approximately 1.5 milliamperes per side.

4.2.2.2 POWER AMPLIFIER

Electrically, the power amplifier consists of transistors A1Q10 through A1Q24, and associated components.

Resistors A1R99 and A1R100 are connected so as to supply a constant current to bias the output stage. This is accomplished by bootstrapping the junction of A1R99 and A1R100 back to the output via capacitor, A1C33. Static DC bias for the output stage is developed across diode A1CR20 which allows the output stage to operate as a Class A amplifier for no load or low VA load conditions and to operate nearly as a Class B amplifier for large load conditions.

Transistor A1Q10 and associated components are connected in the grounded emitter configuration. Local negative feedback is provided by A1C24, A1C25, A1R93, and A1R94. The local feedback limits the gain of this stage to 30 at 400 Hz. The gain falls off at 6 dB per octave above 1.5 KHz.

The positive polarity output amplifier consists of A1Q18 through A1Q24 connected as emitter followers. These transistors supply a total of 15 amperes peak during the positive one-half cycle of the output waveform when the power source is loaded with a 1200 VA resistive load. These positive output amplifier transistors and their associated heatsink can dissipate over 300 watts with less than a 30°C case temperature rise with an air flow of 80 cfm per heatsink.

The negative polarity output amplifier consists of transistors A1Q11 through A1Q17 connected in the quasi complementary symmetry configuration. These transistors supply a total of 15 amperes peak during the negative one-half cycle of the output waveform when the power source is loaded with a 1200VA resistive load. These negative output amplifier transistors and their associated heatsink can dissipate over 300 watts with less than a 30°C case temperature rise with an air flow of 80 cfm per heatsink.

4.2.2.3 OVERLOAD CIRCUITS

The overload section of the correction amplifier is used to protect the correction amplifier during overload. Semiconductor device A1Q9 is a triac which is activated by a control signal applied to its gate terminal. During normal operation, the triac is an open circuit and does not affect operation of the correction amplifier. During overload, the gate of the triac is turned "on" and terminal 2 of the triac is clamped to ground. This, in turn, causes the voltage at the cathode of A1CR20 to go to zero volts. The output of the correction amplifier also goes to zero volts as it tracks the voltage at the cathode of A1CR20.

During overload, the output of the correction amplifier is also clamped to ground by a power triac, A1Q26. The static current in the output stage is significantly reduced and the dynamic line corrector delivers unregulated power through the series circuit formed by the power winding S4 of the power transformer and the power triac A1Q26.

4.2.3 POWER SUPPLY

The +44 volt supply provides unregulated +42 volts at 5.0 amperes average current (15 amperes peak) to the correction amplifier when the line corrector is delivering 1200 VA. Under this condition, the ripple on the +44 volt supply is approximately 2 volts peak-to-peak at 120 Hz. Under no load conditions, the +44 volt supply delivers approximately +47 volts.

The -44 volt supply provides unregulated -42 volts at 5.0 amperes average current to the correction amplifier when the line corrector is delivering 1200 VA. Under this condition, the ripple on the -44 volt supply is approximately 2 volts peak-to-peak at 120 Hz. Under no load conditions, the -44 volt supply delivers approximately -47 volts.

The +15.4 volt supply consists of transistor A1Q4 and associated components. The +15.4 volt supply delivers 50 milliamperes with less than 10 millivolts peak-to-peak ripple at 120 Hz.

The -15.4 volt supply is contained on the power supply circuit board and consists of transistor A1Q5 and associated components. The -15.4 volt supply delivers 50 milliamperes with less than 10 millivolts peak-to-peak ripple at 120 Hz.

The +22 volt supply is obtained directly from the junction of diodes A1CR10 and A1CR12 and supplies the power for the OVERLOAD lamp and for portions of the overload circuitry.

4.2.4 OVERLOAD SENSING CIRCUITS

The overload circuitry consists of integrated circuits A1IC11, A1IC12, A1IC13, A1IC14, A1IC15, transistors A1Q25, A1Q27, A1Q28, A1Q29, and associated components. This circuitry is broken down into the following sections:

a) Precision Rectifier and Integrator

b) Schmitt Trigger

c) Flip-flop Circuit

d) Zero Crossing Detector

e) Logic Control and Time Delay

4.2.4.1 PRECISION RECTIFIER AND INTEGRATOR

The precision rectifier and integrator consist of integrated circuits A1IC11, A1IC13 and associated components. Resistor R2, in the output power circuit, is used to sense the line corrector load current. The voltage drop across R2, approximately 0.15 volts peak with 1200 VA load, is applied to A1IC11 and A1IC13 via resistors A1R69 and A1R74, respectively. The output of the integrator, at A1IC13 pin 6, is approximately +5 volts DC with a 1200 VA load. This output is used to drive both the ammeter M1 and the overload Schmitt trigger, A1IC14. Potentiometer A1R81 is used to adjust the output voltage of A1IC13 to 0 volts DC under no load conditions.

4.2.4.2 SCHMITT TRIGGER

The Schmitt trigger consists of integrated circuit A1IC14 and associated components. The output of the Schmitt trigger, at A1IC14 pin 6, is normally +15 volts DC, unless the input to the Schmitt trigger, at A1IC14 pin 2, is greater than the trigger level. This trigger level, approximately +6 volts, is controlled potentiometer A1R96. Potentiometer A1R96 is normally set to activate the Schmitt trigger circuit at a 25 per cent overload (1500 VA load on LC 1201B Line Corrector).

When the input signal to the Schmitt trigger reaches or exceeds the trigger level, the output, at A1IC14 pin 6, switches to -15 volts which, in turn, allows the cathode of A1CR22 to drop to zero volts.

4.2.4.3 FLIP-FLOP CIRCUIT

The flip-flop circuit consists of CMOS integrated circuit A1IC15-B and A1IC15-C. This flip-flop is used as a memory to store the overload condition. When either A1IC15-B pin 1 or pin 2 is momentarily driven to zero volts, the output of the flip-flop A1IC15-B at pin 9 will "lock-up" at +15 volts. The flip-flop is reset by momentarily driving A1IC15C pin 12 to zero volts.

The output of the flip-flop is used to drive power triac A1Q26 via A1Q25 and A1Q29 and to drive low-level clamp triac A1Q9 via emitter follower A1Q28.when an overload condition exists.

Transistor A1Q25 is connected as a zener diode with a breakdown voltage of approximately 6.5 volts. This insures that the low-level clamp triac A1Q9 is turned on prior to the power triac A1Q26 when an overload occurs. When the overload is removed, this zener diode (A1Q25) functions so as to remove the drive from the gate of A1Q26 slightly before it is removed from A1Q9.

4.2.4.4 ZERO CROSSING DETECTOR

The zero crossing detector consists of integrated circuit A1IC12 and associated components and is driven from the sense winding of the power transformer T1 via resistor A1R71. The output of the zero crossing detector at A1IC12 pin 6 is a 30 volts peak-to-peak square wave at the input line frequency rate and in phase with the signal at pin 6 of transformer T1.

Capacitor A1C26, resistor A1R95 and diode A1CR18 provide a pulse forming network which acts so as to differentiate the output of the zero crossing detector and make it level compatiable with CMOS integrated circuit A1IC15.

4.2.4.5 LOGIC CONTROL AND TIME DELAY

The logic control and time delay consist of CMOS integrated circuit A1IC15-A and associated components. Integrated circuit A1IC15-A is a three input NAND gate whose output is used to reset the flip-flop output after an overload condition has been removed.

In order to reset the flip-flop, all three inputs to this NAND gate A1IC15-A must be simultaneously in the "high" state (+15 volts). Pin 3 of A1IC15-A is in the "high" state when the overload signal is removed from the Schmitt trigger; pin 4 of A1IC15-A is in the "high" state after the time delay circuit has charged to +15 volts; and pin 5 of A1IC15-B is in the "high" state momentarily as the zero crossing detector output goes from -15 volts to +15 volts.

The time delay circuit consists of resistor A1R103 and capacitor A1C28 and are only used during initial application of power to the line corrector. This delay causes the flip-flop to turn-on in the overload state and to stay in the overload state for at least two seconds after power is applied to the line corrector. This allows the amplitude and phase servo loops in the reference generator adequate time to stabilize before any load current is drawn from the power amplifier.

This reduces the electrical stress on the output transistors during start-up and, thereby provides more reliable operation of the line corrector.

4.2.5 FRONT PANEL METER

The front panel meter M1 has a full scale sensitivity of 1 milliampere DC and an internal resistance of approximately 100 ohms. The meter has a dual scale with full scale ranges of 0-150 volts and 0-15 amperes. The meter scaling circuitry is located on the A1 assembly. A three position front panel switch S1, enables either the input or output voltage or the output current of the line corrector to be monitored.

The voltmeter circuitry consists of rectifier diodes A1CR25 through A1CR28, potentiometer A1R134, and resistor A1R135. The four rectifier diodes are connected so as to form a full wave bridge rectifier. Potentiometer A1R134 is used to shunt a small portion of the meter current and provide a calibration adjustment on the 0-150 volt scale.

The ammeter circuitry consists of resistor A1R98, potentiometer A1R105 and meter M1. The meter is driven from the overload integrator A1IC13 when switch S1 is in the output current position. Integrated circuit A1IC13 provides a DC drive which is proportional to the line corrector load current. Potentiometer A1R105 is used to calibrate the meter M1 when it is being used as an ammeter.

4.2.6 OVERVOLTAGE PROTECTION CIRCUIT

The overvoltage protection circuit detects any abnormal output voltage condition and trips the front panel circuit breaker thereby protecting the load as well as minimizing any circuit damage.

The overvoltage board, 1120-704, is located under the bottom cover toward the front panel.

The circuitry is broken down into the following sections.

a) Power Supply

b) AC overvoltage sensing

c) DC overvoltage sensing

d) Error comparators/relay drive

e) Delay circuit

The power supply consists of voltage regulators U1 and U2 with associated filter capacitors C9, C10, C11, and C12. It provides ±18VDC for all circuitry on this board. Except for relay K1 power.

The AC overvoltage sensing circuit consists of transformer T1, bridge rectifier BR1, resistors R9, R10, R11, R12, and capacitors C6 and C7. The primary of T1 has impressed on it the conditioned output voltage. This is stepped down to a useable level on the secondary which results in +24V DC at the positive terminal of C6, after rectification by BR1. Further filtering with R9 and C7 results in +13VDC applied to R10 and R11 set the input levels to the error comparators.

The DC overvoltage sensing circuit consists of Integrated Circuit U3, Resistors R1a, R1b, R2, R3, R4, R5, R6, R7, R8 and Capacitors C1, C2, C3, C4, C5, C(A), C(B), C(C), C(D) and C(E). Integrated Circuit U3 is connected as an active filter which has a DC gain of 0.7. The filter effectively removes the AC portion of the output voltage and leaves any DC offset which may be present emanating from the error correction amplifier. Normally this DC offset remains less than 20 millivolts. The voltage divider R7, R8 sets the input level to the error comparators.

The error comparators, integrated circuit U4, are normally at -15V on their outputs. When a difference exists between the inverting and non-inverting inputs the output of one or the other or both will transition to approximately +3.5V. This output will then forward bias CR1 or CR2 and turn on the relay driver Q1. With the activation of K1 an electrical path to the circuit breaker trip coil is completed thus terminating the operation of the LC1201B. Resistor RA and capacitor CF form a filter to prevent false tripping due to unusual transients.

The delay circuit consists of components Q2, R15, R16, R17, CR4, CR5, and C8. The delay circuit is activated during turn-on and inhibits the operation of the overvoltage detector for approximately 10 seconds after the overload signal at J1 pin 5 leaves. The overload signal, +15V, is present for approximately 2 seconds bringing to 12 seconds the total delay time before the overvoltage detector is activated.

WARNING

Voltages up to 125 VAC are available in certain sections of this line corrector. This equipment generates potentially lethal voltages.

DEATH

on contact may result if personnel fail to observe safety precautions. Do not touch electronic equipment when power is applied. Avoid contact with the primary power circuits and the 115 volt AC output circuit of the line corrector.

ADJUSTMENT PROCEDURE

5.1 GENERAL

This adjustment procedure is divided into four sections. These are:

a) Reference Generator Initial Adjustments

b) Preamplifier Initial Adjustments

c) Meter Initial Adjustments

d) Final Adjustments

The REFERENCE GENERATOR INITIAL ADJUSTMENT section need only be performed if repairs have been made to the reference generator. The PREAMPLIFIER INITIAL ADJUSTMENT section need only be performed if repairs have been made to the preamplifier or power amplifier. The METER ADJUSTMENTS and FINAL ADJUSTMENTS should be performed on a yearly basis as well as after any repairs have been made to the line corrector.

Figure 6 shows the location of all the adjustment potentiometers.

5.2 TEST EQUIPMENT REQUIRED

The following test equipment is required to perform the adjustment procedure:

a) Oscilloscope, Tektronix 533A with "W" Plug-in, or equivalent

b) 3 KVA Variac, General Radio W30M, or equivalent

c) 3 KVA Wattmeter, Simpson Electric, or equivalent

d) Differential Voltmeter, Fluke 883A, or equivalent

e) Load Box, 1200 Watts (11.02 ohms ±1%) and 300 Watts (44 ohms ±5%)

f) 250 VA Power Source, California Instruments Model 251TCA with 45/75 Hz Plug-in, or equivalent

g) Phase Meter, Dranetz Series 301, or equivalent

h) 5.0 ohm ±10% 25 watt power resistor

5.3 REFERENCE GENERATOR INITIAL ADJUSTMENTS

These adjustments have been performed at the factory and need not be repeated unless components in the reference generator have been replaced or otherwise misadjusted.

The reference generator, located on the A1 assembly has six adjustable potentiometers, two of which require the availability of a variable frequency power source and a phase meter with 1.0 degree resolution. DO NOT adjust potentiometers A1R27 and A1R45 unless this special purpose equipment is available.

5.3.1 Remove that end of A1R108 (47 ohms) which is connected to the collector of A1Q10. Remove that end of A1R131 (47 ohms) which is connected to resistor A1R100. Connect the floating ends of A1R108 and A1R131 together and tie to A1TP3 (circuit ground). This removes the drive from the power amplifier and allows work to be done on the reference generator without possible damage to the power amplifier.

5.3.2 Connect the Model LC-1201B Dynamic Line Corrector to the wattmeter and power source, rather than to the variac. This connection is shown in the alternate connection of Figure 4.

5.3.3 Apply power to the power source and adjust its output to provide 115 VAC at 60 Hz.

5.3.4 Apply power to the line corrector and allow the circuits to stabilize for a few minutes. The wattmeter should indicate less than 50 watts with the drive signal removed from the power amplifier.

5.3.5 Connect the differential voltmeter from A1TP7 (high side) to A1TP3 (low side) and adjust potentiometer A1R17 so that the differential voltmeter reads -10.0 volts ±50 millivolts DC.

5.3.6 Connect the oscilloscope from A1TP5 (high side) to A1TP3 (low side) and adjust potentiometer A1R2 for a symmetrical square wave.

5.3.7 Set the power source output frequency to 64 Hz and connect the phase meter "A" input to A1TP5, connect the "B" input to A1TP8, and connect the ground return to A1TP3. Adjust potentiometer A1R27 for a phase shift of 180 degrees ±1.0 degree.

5.3.8 Set the power source output frequency to 56 Hz and connect the phase meter "A" input to A1TP8, connect the "B" input to A1TP1, and connect the ground return to A1TP3. Adjust potentiometer A1R45 for a phase shift of 180 degrees ±1.0 degree and then disconnect the phase meter. Return the power source frequency to 60 Hz.

5.3.9 Remove power from the line corrector and discharge filter capacitors C4 and C5 through a 5 ohm power resistor. Remove the ground wire previously connected to A1R108 and A1R131 and re-insert A1R108 and A1R131 in the printed circuit board.

5.3.10 Apply power to the line corrector via the power source/ wattmeter combination and check that the input power is between 50 and 150 watts

5.3.11 Connect the differential voltmeter from A1TP9 (high side) to A1TP3 (low side) and adjust potentiometer A1R58 so that the DC voltage at A1TP9 is 0.0 volts ±50 millivolts DC.

5.3.12 Connect the oscilloscope from A1TP2 (high side) to A1TP3 (low side) and adjust the phasing potentiometer A1R140 for a minimum signal (minimum 60 Hz line frequency component) on the oscilloscope. Rocking the output voltage of the power source in the range from 105 to 115 volts rms will also help to remove the line frequency component from the oscilloscope display.

5.3.13 This completes the adjustment sequence in the reference generator. Replace the power source/wattmeter combination with the variac/ wattmeter combination.

The reference generator should now supply a precision sine wave output, available at A1TP1, with the following characteristics:

a) An amplitude of 5.0 volts rms ±2 per cent

b) An amplitude stability of ±0.02% per hour or better

c) Harmonic distortion less than 0.15 per cent when operating at a 60 Hz output frequency

d) A phase angle of 180 degrees ±10 degrees when referenced to that signal available at transformer T1 pin 6.

5.4 PREAMPLIFIER INITIAL ADJUSTMENTS

The preamplifier has two adjustments. These are for gain and DC offset voltage. Check that the reference generator is operating properly before adjusting the preamplifier.

5.4.1 Connect a low pass filter (10K ohms and 10μfd) to the output of the line corrector and to the differential voltmeter as shown in Figure 5. Apply power to the line corrector and adjust potentiometer A1R64 so that the differential voltmeter reads less than ±20 millivolts DC.

5.4.2 Remove the low pass filter from the output of the line corrector and connect the differential voltmeter directly to the output of the line corrector. Set the differential voltmeter on the 1000 VAC range and adjust potentiometer A1R56 so that the output voltage is 115.0 volts ±.05 per cent (±57.5 millivolts rms).

5.5 METER INITIAL ADJUSTMENTS

Check that the preamplifier has been adjusted for gain and DC offset before adjusting the meter circuitry.

5.5.1 With power removed from the line corrector and with the line corrector in the normal horizontal position, set the mechanical adjustment on the front of the panel meter M1 so that it indicates zero.

5.5.2 Re-apply power to the line corrector and select the OUTPUT CURRENT position with front panel switch S1. Adjust potentiometer A1R81 for a zero indication on the front panel meter M1.

5.5.3 Set the front panel switch S1 to the OUTPUT VOLTAGE position and adjust potentiometer A1R134 for a 115 V indication on meter M1.

This completes the sequence of initial circuit adjustments. The line corrector is ready to be connected to a load. Replace the power source with the 60 Hz AC line and Variac if this has not yet been done.

5.6 FINAL ADJUSTMENTS

Apply power to the line corrector via the wattmeter/variac circuit indicated in Figure 4.

5.6.1 Adjust the variac to provide a 115 VAC output and connect a 1200 watt load (11.02 ohms) to the output of the line corrector. The input wattmeter should indicate 1600 to 1800 watts.

5.6.2 Repeat step 5.3.12 except maintain full load on the output of the dynamic line corrector. The minimum signal should appear on the oscilloscope with the Variac somewhere between 110 and 120 volts output. Rock the Variac and potentiometer A1R140 together until a point has been found where the fundamental component (60 Hz) indicated on the oscilloscope display is practically zero.

5.6.3 Repeat steps 5.4.1 and 5.4.2 under full load conditions. Very little change should be required in either of these adjustments.

5.6.4 Connect a 1500 watt load (44 ohms in parallel with the 11.01 ohm load) to the output of the line corrector with the variac adjusted to provide a 104 VAC input to the line corrector. Adjust potentiometer A1R96 until the OVERLOAD light turns completely "on". Reduce the load to 1200 VA, by removing the 44 ohm load, and check that the OVERLOAD light turns "off".

5.6.5 Connect a 1200 watt (11.02 ohm ±1 per cent) load to the output of the line corrector, select the OUTPUT CURRENT mode with S1 and adjust potentiometer A1R105 so that the front panel ammeter reads exactly 10.43 amperes. Care should be taken to use a load resistor whose value does not change more than 0.5 per cent with application of the 1200 watt load.

5.7 OVERVOLTAGE PROTECTION ADJUSTMENT

5.7.1 Start with a completely calibrated and fully operating LC1201B.

5.7.2 Open the jumper connecting the circuit breaker trip coil to the AC line. (Jumper is between CB1-2 and 3)

5.7.3 Verify that the LC1201B output has been set to OVDC ±3 mv. (warmed up). Reset if necessary with A1R64.

5.7.4 Adjust R6 on the overvoltage board for OVDC at U3 pin 6, ±5 mv.

5.7.5 Connect a temporary jumper between U3 pin 6 and circuit board common.

5.7.6 Remove one end of A1R60 from the PC board. (The end connected to A1R56.)

5.7.7 Connect two wire leads, one to A1TP and the other to the still attached end of A1R60.

5.7.8 Connect a 25K variable resistor to the leads in a rheostat configuration. (set the pot to the center of its range)

5.7.9 With the LC1201B operating, set the output voltage to 125VAC with the variable resistor.

5.7.10 Adjust R11 (H1 ADJ) on the overvoltage board to the point where K1 just pulls in.

5.7.11 Set the output voltage to 105VAC with the variable resistor.

5.7.12 Adjust R10 (LO ADJ) on the overvoltage board to the point where K1 just pulls in.

5.7.13 Replace resistor A1R60 and remove the variable resistor and leads.

5.7.14 Set the LC1201B output to 115VAC with A1R56 if required.

5.7.15 Remove the temporary jumper on U3 pin 6 of the overvoltage board.

5.7.16 Remove contact no.1 from the connector that mates with J1 on the overvoltage board. Temporarily protect the exposed contact with tape.

5.7.17 Monitor U3 pin 6 with a voltmeter or scope.

5.7.18 With the LC1201B operating, apply +2VDC ±.5V to J1 pin 1. The output at U3 pin 6 should swing to approximately -1.4V.

5.7.19 Apply -2VDC ±.5V to J1 pin 1. The output at U3 pin 6 should swing to approximately +1.4V.

5.7.20 Replace contact No. 1 in the connector.

5.7.21 Replace the jumper on the circuit breaker. (CB1-2 to 3)

5.7.22 With the LC1201B running, slowly reduce the input line voltage to the point where the output drops out of regulation. As the output drops further CB1 should activate.

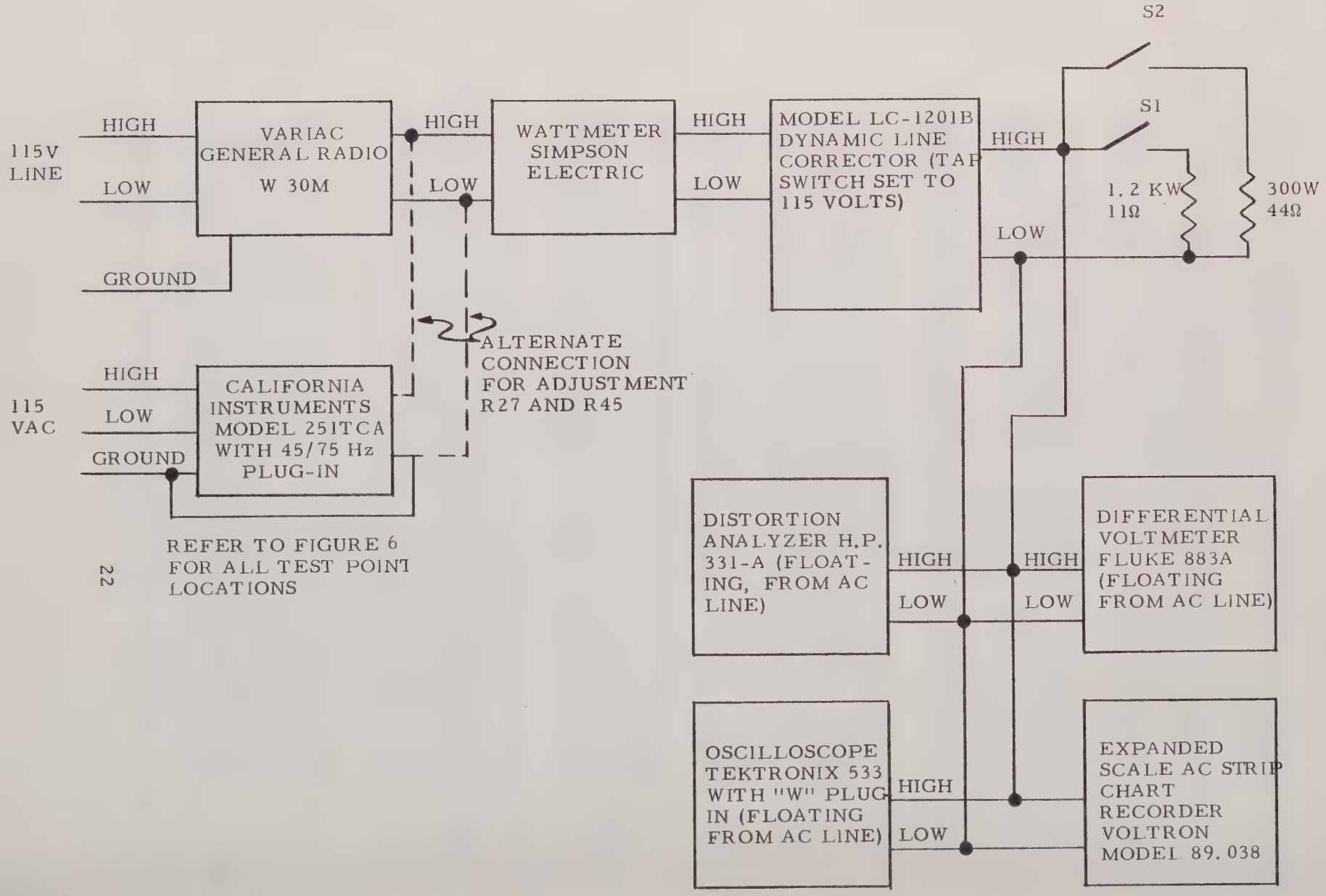


FIGURE 4. Test Circuit for Model LC-1201B Dynamic Line Corrector

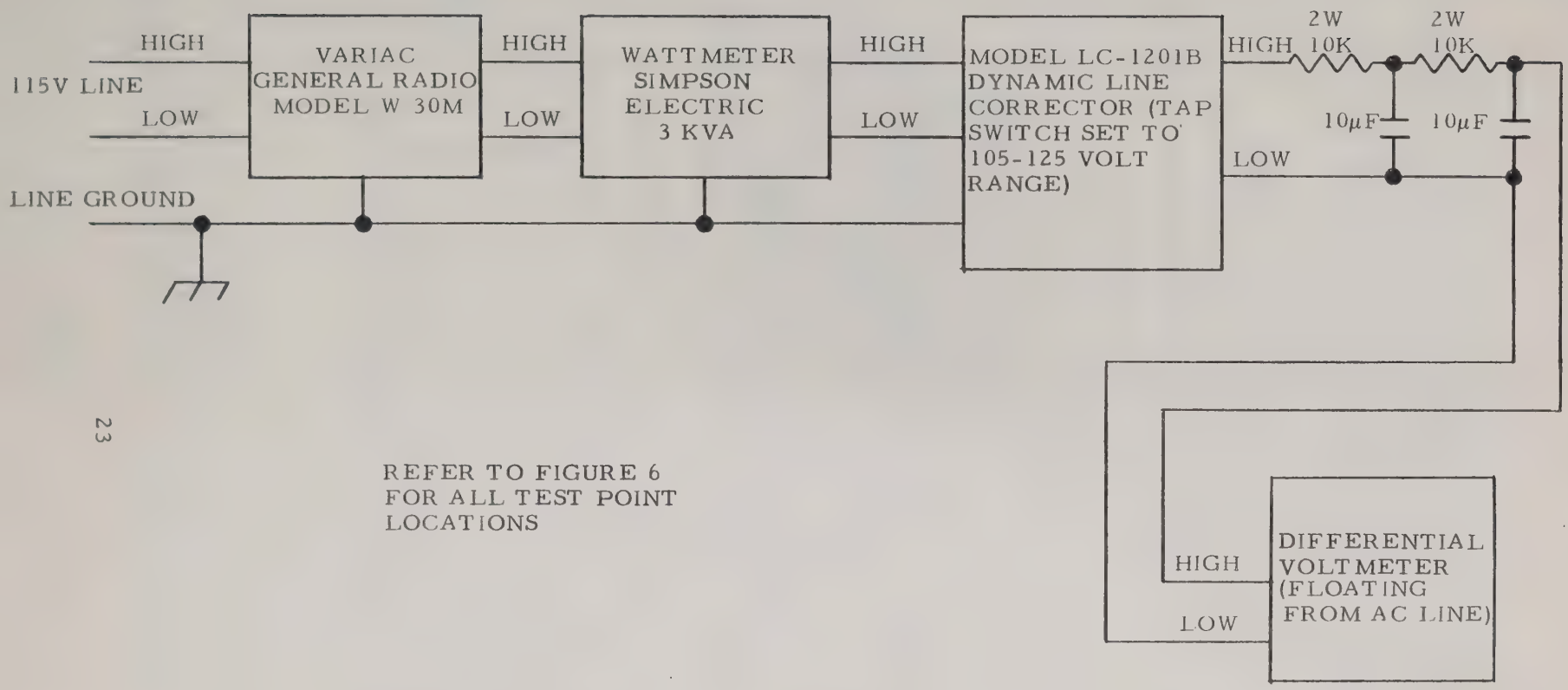


FIGURE 5. Test Circuit for Adjusting the DC Component in the Output of the Line Corrector Equal to Zero

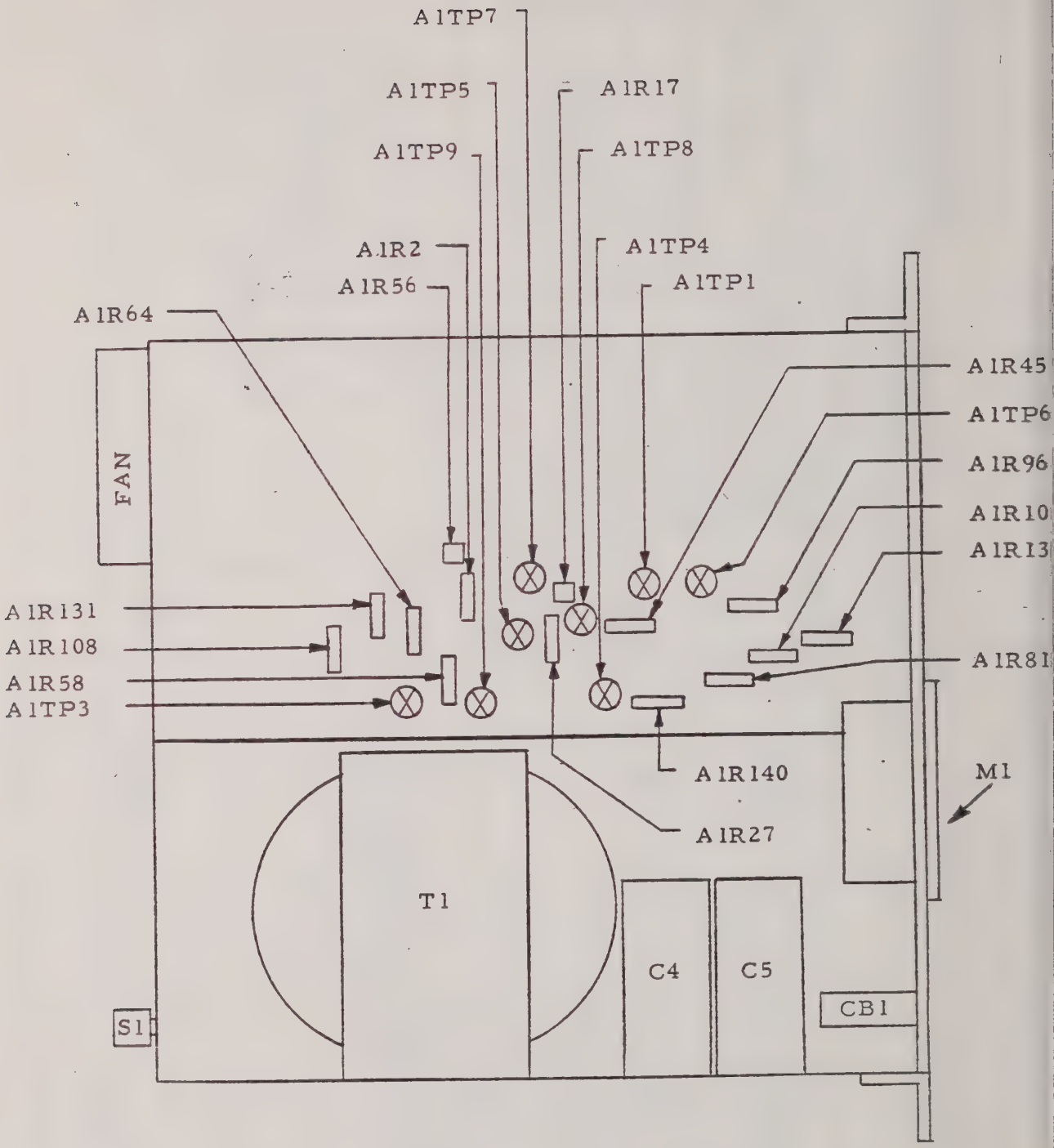


FIGURE 6

ADJUSTMENTS AND TEST POINTS
FOR MODEL LC-1201B DYNAMIC LINE CORRECTOR

6.1 GENERAL

The purpose of this test procedure is to allow the user to test this line corrector to its published specifications and to aid in defining whether the unit is malfunctioning in any fashion. The unit should be adjusted according to the adjustment procedure prior to following this test procedure. This procedure covers test methods for the following line corrector specifications:

a) Output Voltage Stability

b) Output Voltage Temperature Coefficient

c) Line Regulation

d) Load Regulation

e) Harmonic Distortion

f) Transient Characteristics

6.2 TEST EQUIPMENT REQUIRED

The following additional test equipment is required, in addition to that called out in section 5.2 of this instruction manual:

a) Distortion Analyzer, H.P. 331A or equivalent

b) Expanded scale (about 115 VAC) strip chart recorder, Voltron Model 89.038 or equivalent.

c) 1.0 ohm 225 watt adjustable power resistor

d) Honeywell Model 4881 Transient Generator

WARNING

Voltages up to 125 VAC are available in certain sections of this line corrector. This equipment generates potentially lethal voltages.

DEATH

on contact may result if personnel fail to observe safety precautions. Do not touch electronic equipment when power is applied. Avoid contact with the primary power circuits and the 115 volt AC output circuit of the line corrector.

6.3 OUTPUT VOLTAGE STABILITY AT CONSTANT LINE, LOAD and TEMPERATURE

6.3.1 Connect the Model LC-1201B Dynamic AC Line Corrector as shown in Figure 4 and connect the 1200 watt load to the output. Apply power to the line corrector and adjust the input line voltage to 115 volts AC.

6.3.2 Start the strip chart recorder and record the drift during a 24 hour period. This drift should be less than ±57.5 millivolts rms. Disregard the drift during the first one hour as this represents initial warm-up drift. Care should be taken to insure that the ambient temperature is held constant, ±3 degrees, for this test.

6.4 OUTPUT VOLTAGE TEMPERATURE COEFFICIENT

6.4.1 Place the Model LC-1201B Dynamic AC Line Corrector in a large environmental chamber and connect as shown in Figure 4. Connect the 1200 watt load to the output of the line corrector. Apply power to the line corrector and adjust the input line voltage to 115 volts AC. Allow the line corrector to warm-up for one hour while maintaining the ambient temperature at 25 degrees C.

6.4.2 After one hour, record the AC reading of the differential voltmeter for future reference.

6.4.3 Raise the ambient temperature of the environmental chamber to 50 degrees C and allow the line corrector to stabilize for one hour. Maintain the ambient temperature in the chamber at 50 degrees C ±2 degrees. After one hour, record the AC output of the line corrector with the differential voltmeter.

6.4.4 The difference in output voltage between steps 6.4.2 and 6.4.3 must be less than 144 millivolts rms.

6.5 LINE REGULATION

6.5.1 Connect the Model LC-1201B Dynamic AC Line Corrector as shown in Figure 4 and connect the 1200 watt load to the output. Apply power to the line corrector and adjust the input line voltage to 103.5 volts AC. Record the AC output of the line corrector with the differential voltmeter.

6.5.2 Increase the input line voltage to 126.5 volts AC and record the output of the line corrector with the differential voltmeter.

6.5.3 The difference in the output voltage of the line corrector between steps 6.5.1 and 6.5.2 must be less than 57 millivolts rms.

6.6 LOAD REGULATION

6.6.1 Connect the line corrector as shown in Figure 4 and connect the 1200 watt load to the output. Apply power to the dynamic line corrector and adjust the input line voltage to 115 volts AC. Record the AC output of the line corrector with the differential voltmeter.

6.6.2 Remove the 1200 watt load from the output of the line corrector. Readjust the input voltage to the line corrector to 115 volts AC, if necessary. Record the AC output of the line corrector with the differential voltmeter.

6.6.3 The difference in output voltage between steps 6.6.1 and 6.6.2 must be less than 29 millivolts rms.

6.6.4 The above procedure may be repeated for 103.5 volt and 126.5 volt AC line voltages, if required.

6.7 HARMONIC DISTORTION

6.7.1 Connect the Model LC-1201B Dynamic AC Line Corrector as shown in Figure 7. Provision should be made for connecting the distortion analyzer and differential voltmeter to either the input of the line corrector or to the output of the line corrector.

6.7.2 Apply power to the circuit in Figure 7 and allow to warm-up for 2 minutes under full load.

6.7.3 Connect the input of the distortion analyzer and the input of the differential voltmeter as shown in switch position B. Check that the output of the line corrector is 115 volts ±.15 per cent.

6.7.4 Connect the input of the distortion analyzer and input of the differential voltmeter as shown in switch position A. Adjust the 750 ohm rheostat until the total harmonic distortion is 10 per cent. Adjust the Variac so that the input line voltage is 105 volts ±.5 per cent.

6.7.5 Connect the distortion analyzer to switch position B and measure the output distortion. The total harmonic distortion must be less than 0.2 per cent.

6.7.6 Repeat steps 6.7.4 and 6.7.5 except adjust the Variac so that the input line voltage to the line corrector is 125 volts ±.5 per cent. The total harmonic distortion at the output of the line corrector must be less than 0.2 per cent.

6.8 STEP LINE CHANGE

6.8.1 Connect the Model LC-1201B Dynamic AC Line Corrector as shown in Figure 8 and close switches S1 and S2. Apply power to the line corrector and allow a 2 minute warm-up under full load.

6.8.2 Adjust the Variac so that the input voltage to the line corrector is 115 volts. Open switch S1, the input voltage to the line corrector should drop to 105 volts ±1 volt. Adjust R1 slightly, if the input voltage is below 105 volts.

6.8.3 Set the oscilloscope on the .2 second per centimeter range and adjust the "W" plug-in to observe the positive peaks of the sine wave at a sensitivity of 0.2 volt per centimeter.

6.8.4 Manually close S1 at such a time so as to observe the switching transient at the output of the line corrector. The peak transient should not exceed 0.8 volt and should recover to 0.08 volt of final value within 0.5 second.

6.8.5 Repeat 6.8.4 except observe the switching transient while S1 is opened. The peak transient should not exceed 0.8 volt and should recover to 0.08 volt of final value within 0.5 second.

6.8.6 Repeat 6.8.2 except adjust the Variac to 125 volts at the input of the line corrector with S1 closed. Open switch S1, the input voltage to the line corrector should drop to 115 volts ±1 volt. Adjust R1 slightly, if the input voltage is below 115 volts.

6.8.7 Repeat steps 6.8.3, 6.8.4 and 6.8.5. The peak transient should not exceed 0.8 volt and should recover to 0.08 volt of final value within 0.5 second.

6.9 STEP LOAD CHANGE

6.9.1 Connect the Model LC-1201B Dynamic AC Line Corrector as shown in Figure 8 and close switch S1 and switch S2. Apply power to the line corrector and allow a 2 minute warm-up under full load.

6.9.2 Adjust the Variac so that the input voltage to the line corrector is 115 volts. Open switch S2, the input voltage to the line corrector should not increase more than 2 volts. If the line voltage increases more than 2 volts, connect the equipment to the AC power line system with greater current handling capacity.

6.9.3 Set the oscilloscope on the .2 second per centimeter range and adjust the "W" plug-in to observe the positive peaks of the sine wave at a sensitivity of 0.2 volt per centimeter.

6.9.4 Manually close S2 at such a time so as to observe the switching transient at the output of the line corrector. The peak transient should not exceed 0.8 volt and should recover to 0.08 volt of final value within 0.5 second.

6.9.5 Repeat 6.9.4 except observe the switching transient as switch S2 is opened. The peak transient should not exceed 0.8 volt and should recover to 0.08 volt of final value within 0.5 second.

6.10 CYCLE TO CYCLE PEAK AMPLITUDE INSTABILITY

6.10.1 Connect the line corrector as shown in Figure 8 and close switch S2. Apply power to the line corrector and allow a 2 minute warm-up under full load.

6.10.2 Adjust the Variac so that the input voltage to the line corrector is 115 volts.

6.10.3 Connect the oscilloscope to the input of the line corrector so that one cycle of the 60 Hz line is spread across 10 centimeters in the horizontal direction (1.66 milliseconds per centimeter). Operate the oscilloscope in the positive slope internal line sync mode of operation. Expand the sweep about the negative slope zero crossing in the center of the oscilloscope screen until the vertical sensitivity is at least 1 volt per division and the X100 sweep multiplier is in the X100 position. Observe the peak-to-peak jitter in the horizontal direction on the oscilloscope. This jitter must be less than 1.0 centimeter peak-to-peak (16.6 microseconds or ±.18 degrees).

6.10.4 Connect the oscilloscope to the output of the line corrector and set the oscilloscope on the 0.1 second per centimeter scale, set the sweep multiplier to X1, adjust the "W" plug-in to observe the positive peaks of the sine wave at a sensitivity of 0.1 volt per centimeter. Each centimeter of horizontal sweep will now contain approximately six positive peaks. Check that each peak is not greater than 0.032 volt different than the adjacent peak. It may be desirable to repeat this test at sweep rates of 0.05 second per centimeter and 0.2 second per centimeter.

6.10.5 Repeat step 6.10.4 except set the "W" plug-in to observe the negative peak of the sine wave.

6.10.6 If step 6.10.3 indicated to a greater jitter than ±0.18 degree, then the cycle-to-cycle amplitude instability indicated in steps 6.10.4 and 6.10.5 will be proportionally greater.

6.11 IMPULSE SETTLING TIME

This test is to insure that the Model LC-1201B Dynamic AC Line Corrector has the required high frequency response to attenuate high frequency line and load transients. This test is normally run for load transients only, but gives valid results for line transients.

6.11.1 Connect the above equipment as shown in Figure 9. Turn on the +6 volt and -20 volt power supplies. The +6 volt supply should draw negligible current at this time. The -20 volt supply should draw approximately 80 to 100 milliamperes.

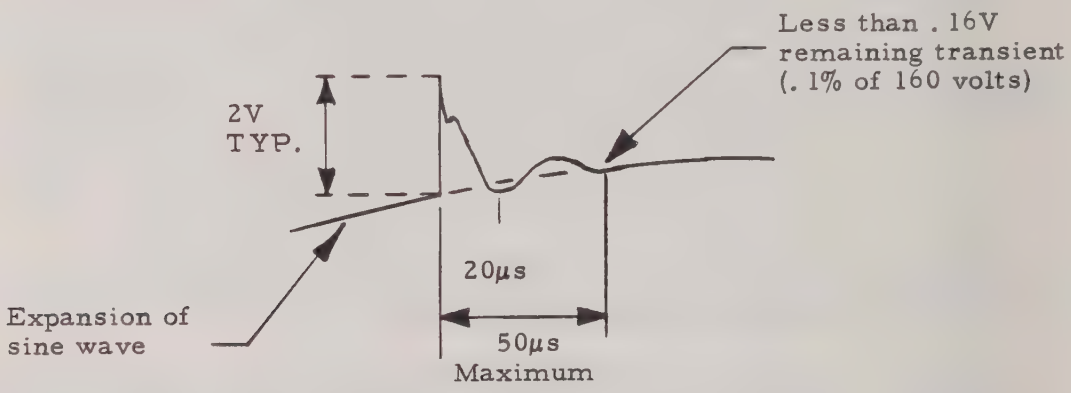
6.11.2 Turn on the pulse generator and synchronize its output to the incoming 115 volt AC line. Adjust the pulse width to 1 millisecond and its amplitude to +6 volts. The +6 volt supply should now deliver approximately 150 milliamperes.

6.11.3 With switch S1 open, apply line power to the line corrector. Check that the output of the line corrector is 115 volts ±.15 per cent. Also adjust the Variac so that the input to the line corrector is 115 volts.

6.11.4 Adjust the delay time of the pulse generator so that the 1 millisecond output pulse is synchronized with the positive peak of the 115 volt sine wave out of the line corrector as shown in Figure 9.

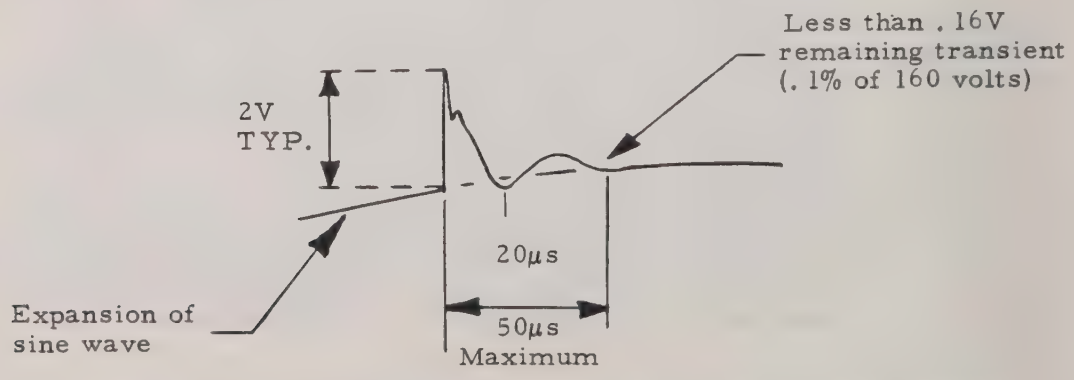
6.11.5 At this time, the California Instruments #96129 test fixture will draw a 1 ampere, 1 millisecond current pulse from the output of the line corrector during the positive peak of each cycle.

6.11.6 Connect the high input of the oscilloscope to point A and expand the oscilloscope display in both time and amplitude about the "Leading Edge Firing Point". Expand the sweep rate until the effective sweep rate is 20 microseconds per centimeter at the "Leading Edge Firing Point". Expand the vertical sensitivity until the effective sensitivity is 1 volt per centimeter at the "Leading Edge Firing Point". The following transient should be observed at the "Leading Edge Firing Point":



The length of this transient must be less than 50 microseconds to 0.1 per cent of voltage value (160 volts) as shown above.

6.11.7 Close switch S1 so that the line corrector has a 1200 watt static load. Readjust the oscilloscope slightly about the "Leading Edge Firing Point" if required. The Leading Edge transient should look approximately the same except as indicated below.



The length of this transient must be less than 50 microseconds to 0.1 per cent of voltage value (160 volts) as shown above.

6.12 TRANSIENT RESPONSE

This test is to insure that the LC-1201B Dynamic AC Line Corrector will attenuate a high voltage, 10 microsecond input line transient by 1000 to 1.

6.12.1 Connect the equipment exactly as shown in Figure 10.

6.12.2 Turn on the LC-1201B Dynamic AC Line Corrector and the transient generator and set the transient generator for 60 Hz SYNC.

6.12.3 Properly set the oscilloscope X10 probe attenuator compensation with the 533 oscilloscope internal calibration signal. Connect the oscilloscope with the X10 probe across the input to the line corrector. Use the grounding clip lead at the probe tip for the low connection so as to minimize stray pick-up. Set the oscilloscope to + line sync.

6.12.4 Set the AMPLITUDE control of the transient generator for a 500 volt peak-to-peak output. Adjust the LINE SYNC and PULSE POSITION controls to position the transient on the positive peak of the displayed waveform.

6.12.5 Short the scope probe high lead to its low lead at the low output of the LC-1201B line corrector. Note the scope pick-up noise from the transient generator. The amount of pick-up depends on the common mode rejection of the particular oscilloscope used and on the quality of the power line ground. Repositioning the oscilloscope so that it is not physically near the transient generator will minimize the direct radiation into the oscilloscope.

6.12.6 Connect the X10 probe across the line corrector output keeping the common of the oscilloscope on the line corrector low and look at the positive peak utilizing the DC offset provision of the "W" plug-in. The PULSE POSITION control on ;he transient generator may have to be adjusted to position the transient properly. Examine the displayed waveform at an effective sweep rate of 20 microseconds per centimeter and at a vertical sensitivity of .5 volt per division.

Discounting the high frequency common mode signal observed in 6.12.5, check that the transient amplitude is less than 0.5 volt peak-to-peak.

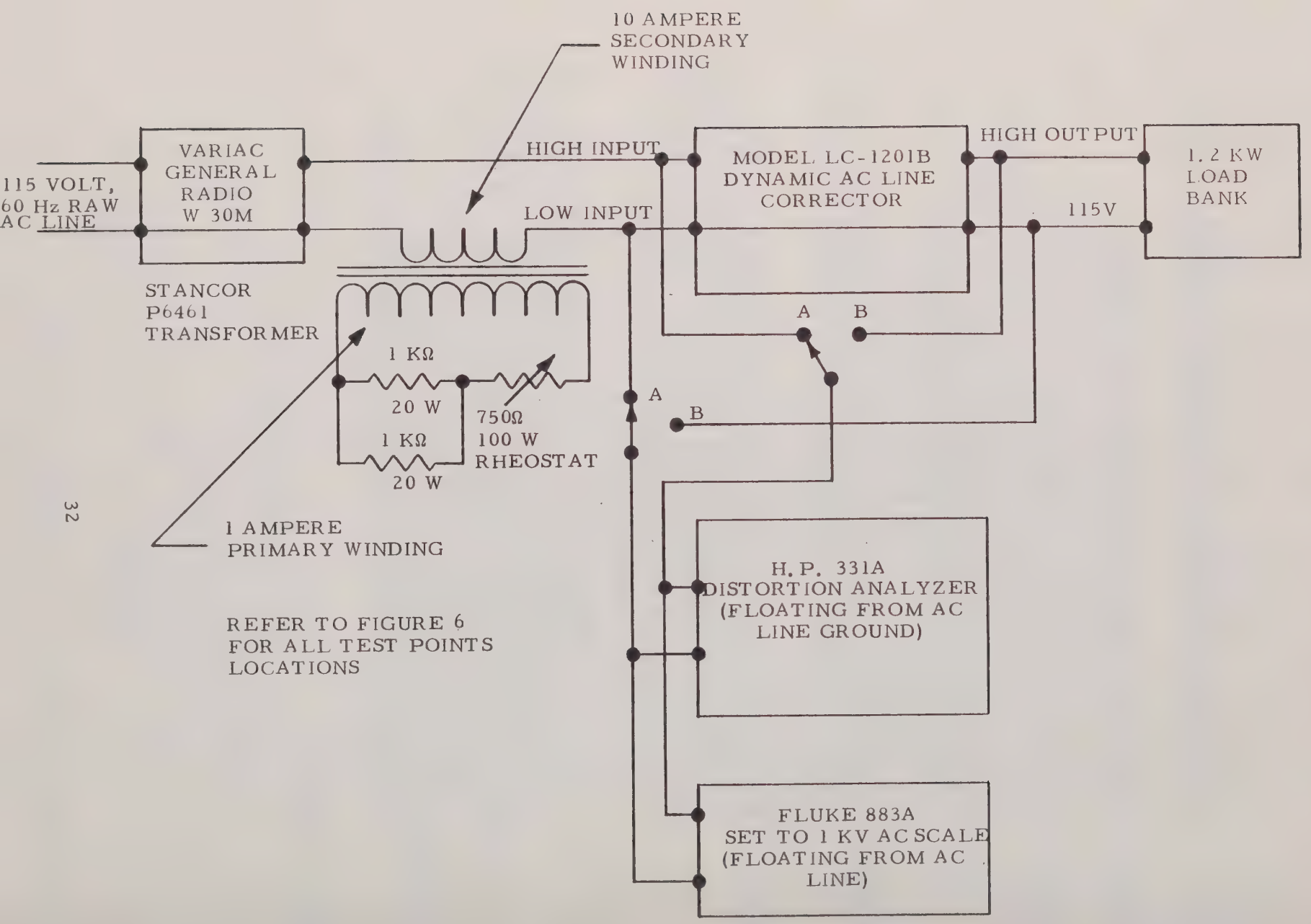
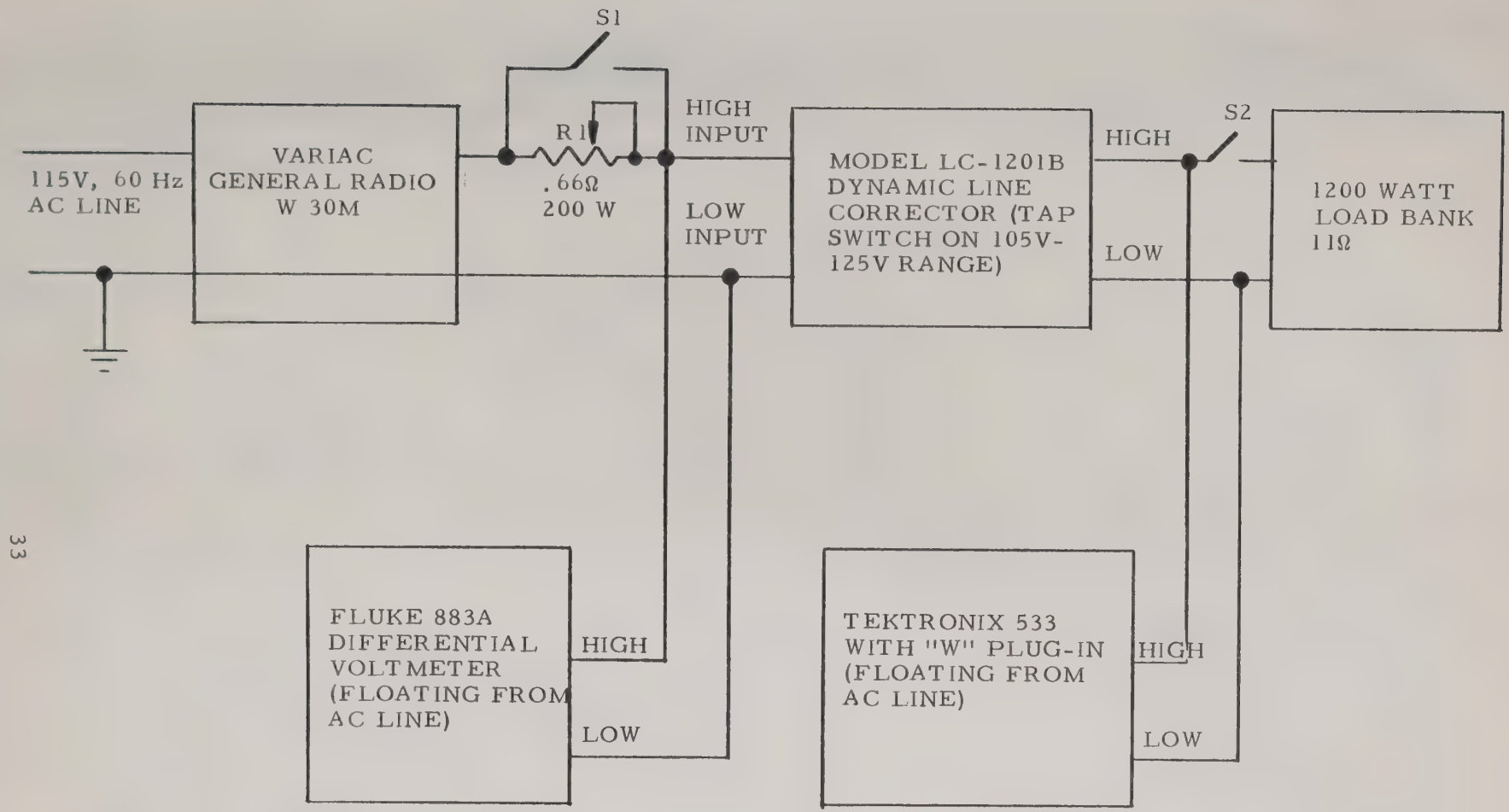


FIGURE 7. Harmonic Distortion Test Circuit for Model LC-1201B Dynamic AC Line Corrector



REFER TO FIGURE 6
FOR ALL TEST POINTS
LOCATIONS

FIGURE 8. Test Circuit for Measuring Step Line and Load Response of Line Corrector

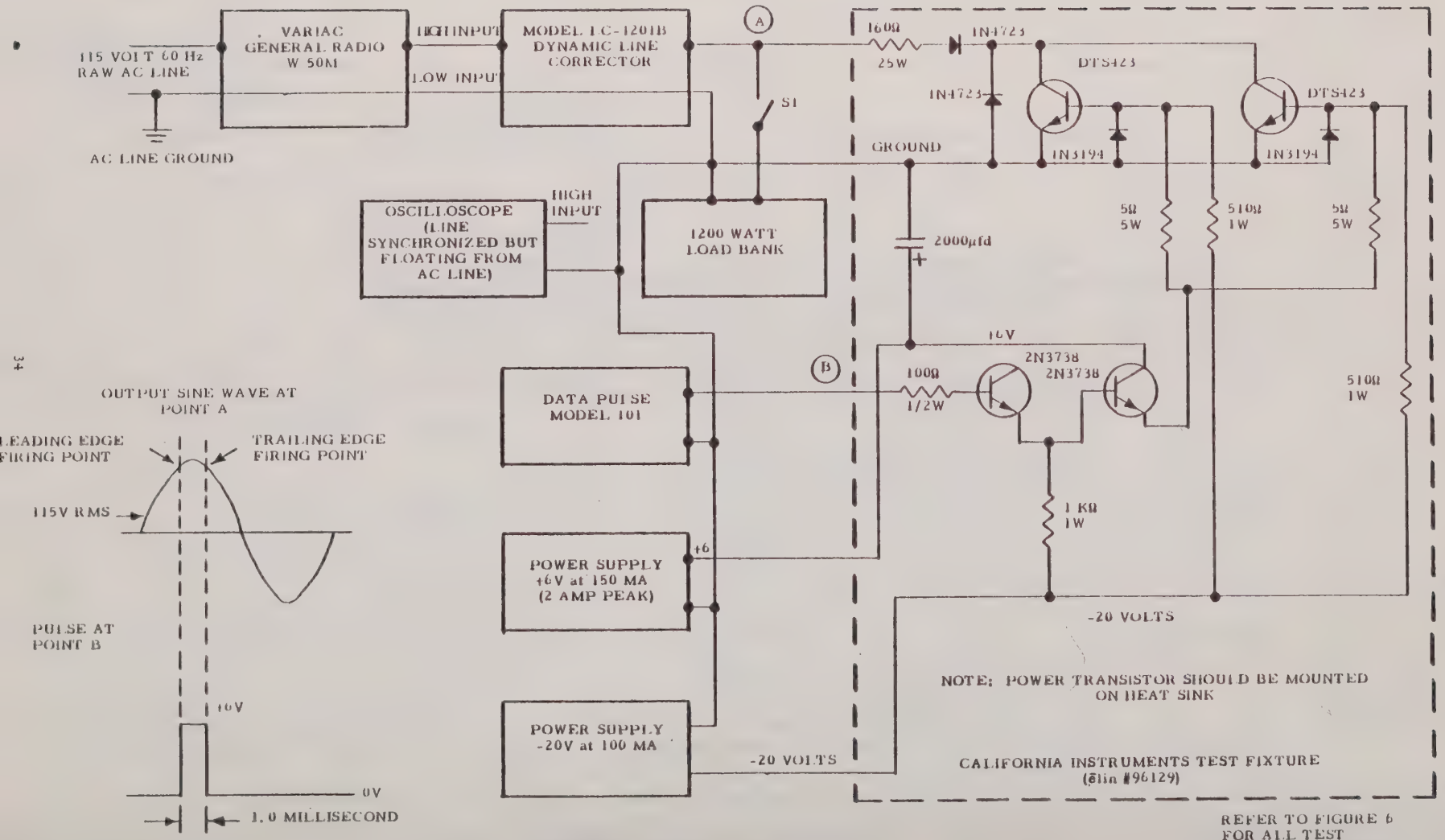


FIGURE 9. Response Time Test Circuit

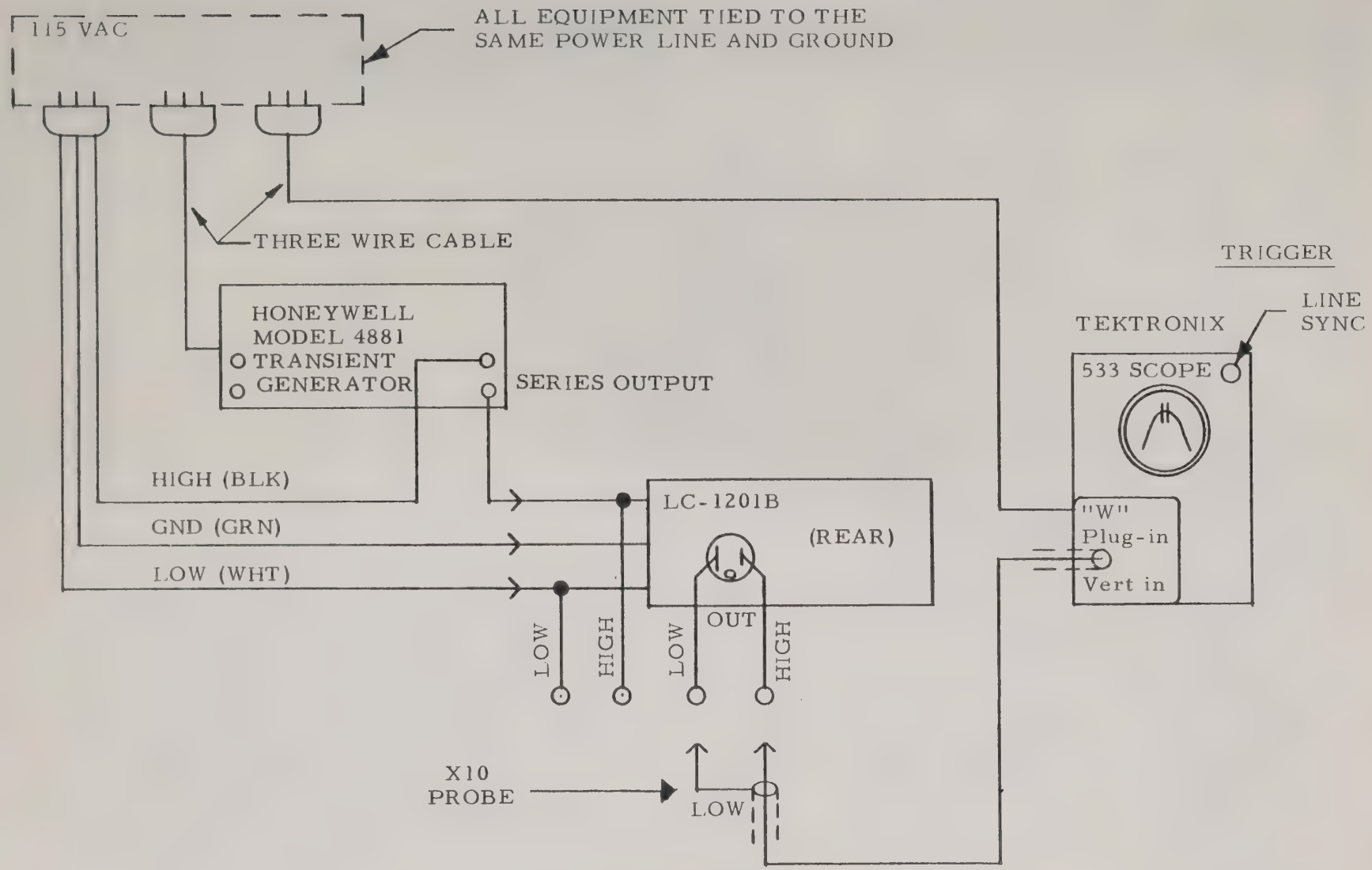


FIGURE 10. Transient Response Test Circuit for Model 1201B Dynamic Line Corrector.

7.1 GENERAL

The Model LC-1201B Dynamic AC Line Corrector is a solid state unit and will require a minimum of maintenance. Careful and regular performance of periodic preventive maintenance will reduce the probability of failure.

7.2 CLEANING

Remove dust, dirt and other foreign material using a small brush and vacuum cleaner. Low pressure air may be used if a vacuum cleaner is not available. When using the air, insure that the air flow is directed so that the foreign material will be blown away from the unit being cleaned. Use a dust-free lint-free cloth and a suitable solvent such as Methyl-Ethyl-Ketone to remove contamination not readily removable by vacuum or forced air methods. When cleaning printed circuit boards, do not scratch the printed circuit wiring. If solvent is used, allow all affected areas to thoroughly air dry prior to placing in use.

7.3 PERIODIC PREVENTIVE MAINTENANCE

The periodic maintenance outlined in the table below should be performed to insure for maximum, failure-free operation of the LC-1201B Line Corrector. Follow safety outlines of this manual when performing any maintenance on this unit. No lubrication is required for the LC-1201B Line Corrector.

PREVENTIVE MAINTENANCE		
Interval	Area of Maintenance	Procedure
Monthly	Exterior of unit, especially front and rear panel.	Inspect controls, indicators, connectors, wiring, and hardware for contamination by dust or dirt, security of mounting or connection, and signs of damage. Inspect fan for free rotation. Follow safety guidelines outlined in this manual.
Bi-yearly	Interior of unit, including individual assemblies.	With power off, remove top and bottom covers of unit. Clean the heatsinks of all dust and dirt using a forced air bath, inspect printed circuit boards for dust, dirt, corrosion, security of mounting and evidence of over heating. Failure to perform this maintenance will result in reduced thermal transfer efficiency and may lead to eventual failure of the equipment.

7.4 TROUBLESHOOTING

WARNING

Voltages up to 125 VAC are available in certain sections of this line corrector. This equipment generates potentially lethal voltages.

DEATH

on contact may result if personnel fail to observe safety precautions. Do not touch electronic circuits when power is applied. Avoid contact with the primary power circuits and the output circuits of the line corrector.

7.4.1 The equipment required for maintenance of this power source is the same as that called out in section 5.2 and 6.2 of this manual. In addition, Triplett Model 630 NA will be valuable for miscellaneous troubleshooting.

7.4.2 If a problem appears in the line corrector, it must be isolated to a specific section of the unit. Before servicing the line corrector, check that the AC power input to the unit is of the proper amplitude and frequency. Check that the output load on the line corrector is not excessive.

7.4.3 If the unit will not turn "on" and trips the front panel circuit breaker, check the output transistors A1Q11 through A1Q24 and associated emitter resistors. Check the power rectifier CR1 and filter capacitor C4 and C5 with an ohmmeter.

7.4.4 After the unit will turn "on" correctly, without activating the input circuit breaker, measure the input power with the wattmeter as shown in Figure 4. The input power should not exceed 150 watts under no load conditions. If the input power exceeds 150 watts check that the power triac A1Q26 is not shorted or otherwise activated. Check that the ±15.4 volt and ±44 volt power supplies are operating within the tolerances given in section 4.2.3 of this instruction manual.

7.4.5 Check that the correct error signal is present at test point A1TP2. If an 80 volt peak-to-peak square wave is present at this point either the power amplifier or reference generator are not operating correctly. Check that the reference generator at A1TP1 is in accordance with the data given in step 5.3.13.

7.4.6 If a 2 volt peak-to-peak square wave is present at A1TP2, check that the low-level triac A1Q9 is not shorted or otherwise activated.

7.4.7 If the error output at A1TP2 is biased off to either +44 volts or -44 volts, check for defective components in the pre-amplifier or perhaps a large DC offset in the output of the reference generator.

7.4.8 Check that the OVERLOAD light comes "on" when power is initially applied to the line corrector and that this light goes out approximately 2 seconds later under no load conditions. Check the zero crossing detector A1IC12, the Schmitt trigger A1IC14 and CMOS NAND gate A1IC15.

7.4.9 The THEORY OF OPERATION and ADJUSTMENT PROCEDURE contained in this manual should be of considerable value in further isolating the cause of any problem.

CIRCUIT DIAGRAM

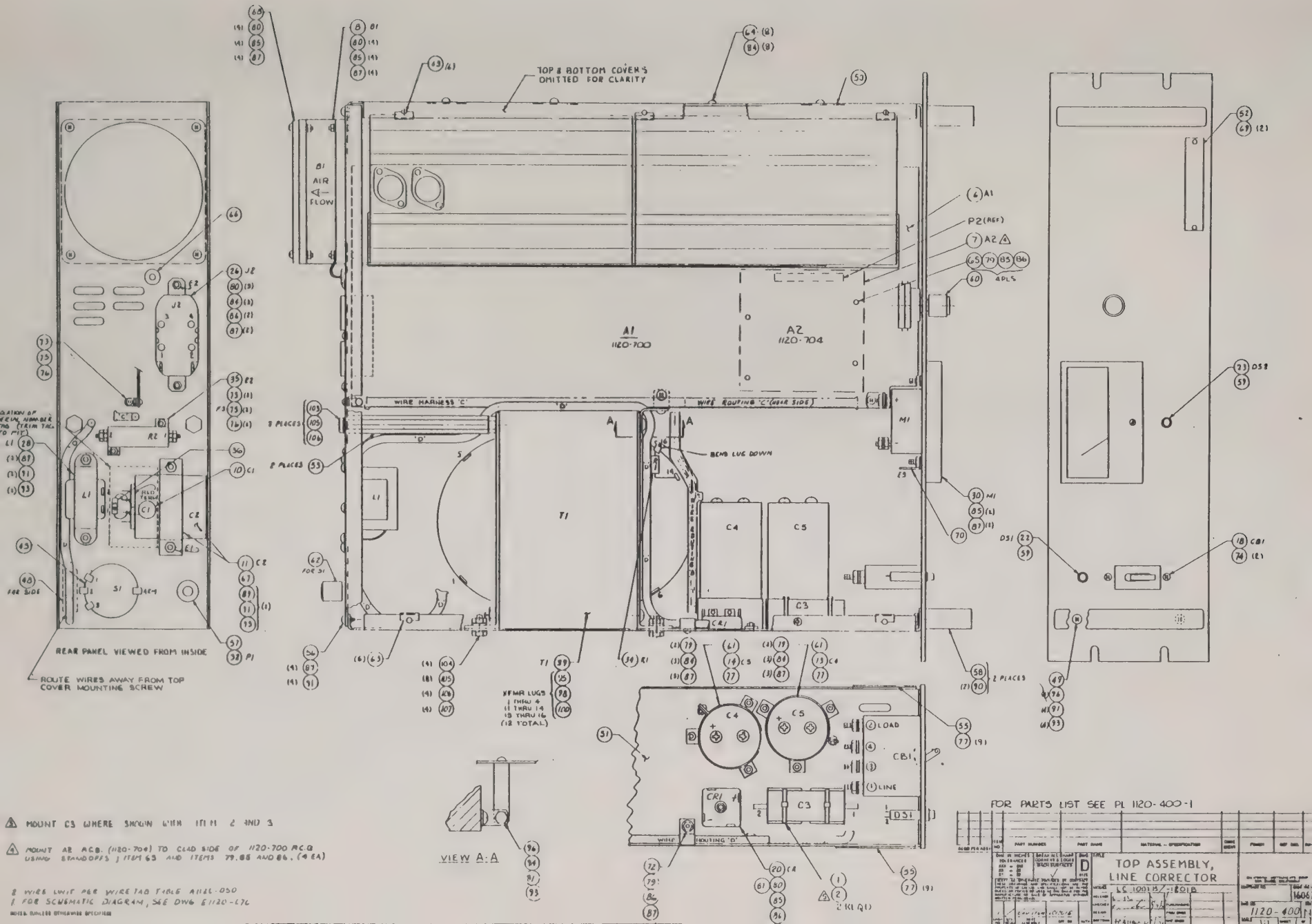
8.1 GENERAL

This section contains schematic and mechanical diagrams necessary for operation and maintenance of the LC-1201B Dynamic AC Line Corrector. The schematic diagram illustrates the circuit while the mechanical assemblies indicate part placement.

8.2 REFERENCE DESIGNATIONS

Partial reference designators are shown on schematics and mechanical drawings. Prefix these reference designators with assembly and/or sub-assembly designation for the complete reference designator. For example:

Assembly/Sub-Assembly	Component	Complete Designation
A1	C30	A1C30
None	T1	T1

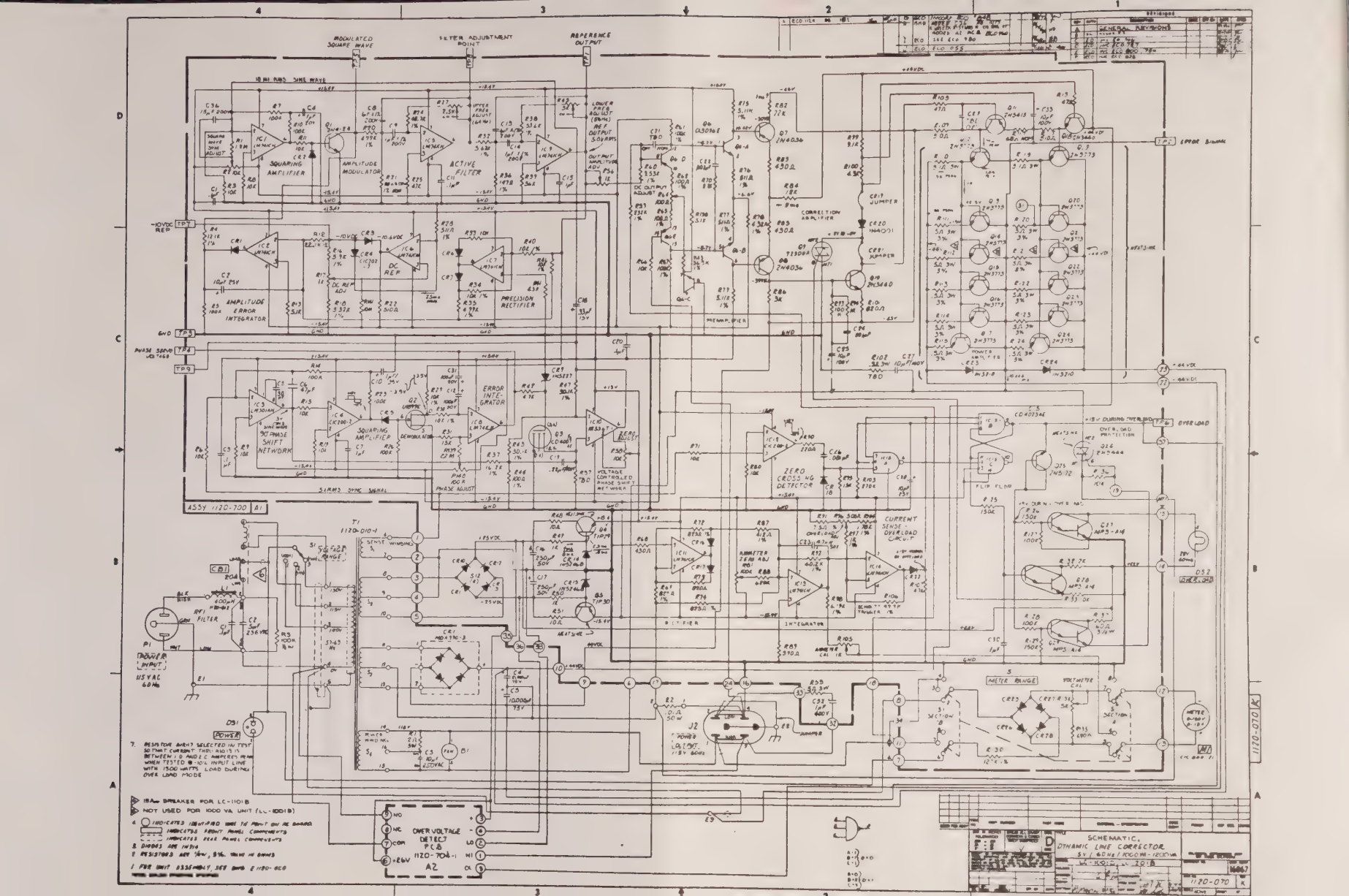


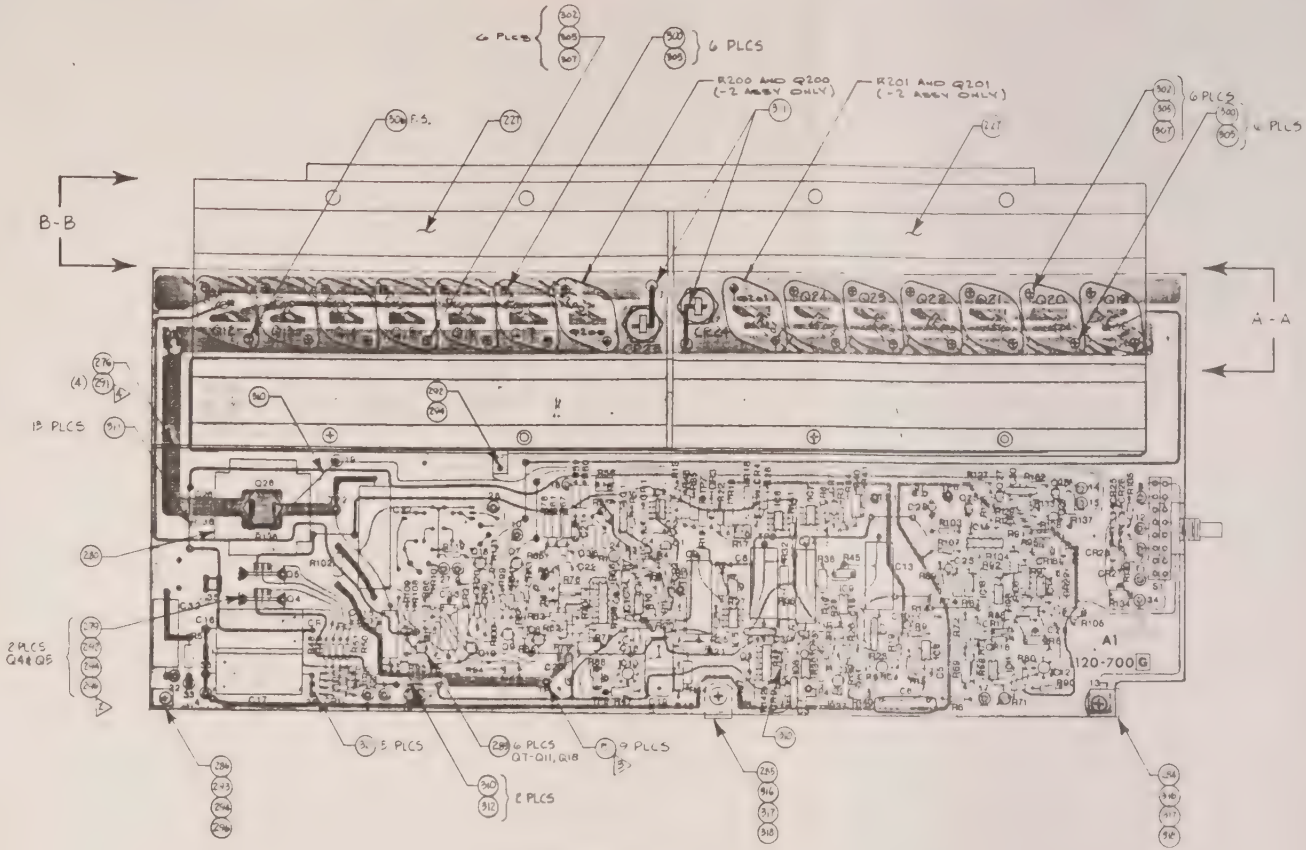
⚠ MOUNT C3 WHERE SHOWN WHEN ITEM 2 AND 3

⚠ MOUNT A2 PCB. (1120-704) TO CLAD SIDE OF 1120-700 PC.B USING STANDOFFS (ITEM 63 AND ITEMS 79, 85 AND 86. (4 EA)

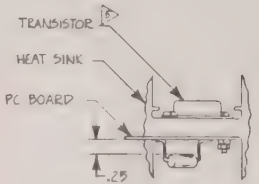
2 WIRES UNIT PER WIRE TAB TABLE A1121-050

1 FOR SCHEMATIC DIAGRAM, SEE DWG E1120-476

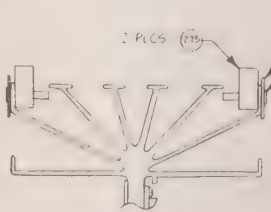

MODULATED SQUARE WAVE
FILTER ADJUSTMENT POINT
REFERENCE OUTPUT
SQUARING AMPLIFIER
AMPLITUDE MODULATOR
ACTIVE FILTER
AMPLITUDE ERROR INTEGRATOR
DC REF ADJ
PRECISION RECTIFIER
CORRECTION AMPLIFIER
PREAMPLIFIER
90° PHASE SHIFT NETWORK
SQUARING AMPLIFIER
ERROR INTEGRATOR
ZERO CROSSING DETECTOR
FLIP FLOP
CURRENT SENSE - OVERLOAD CIRCUIT
INTEGRATOR
OVER VOLTAGE DETECT PCB 1120-704-1 A2
ASSY 1120-700 A1
SCHEMATIC, DYNAMIC LINE CORRECTOR 5V, 60HZ/1000VA-1200VA
1120-070 K



-1 & -2 ASSEMBLY
COMPONENT SIDE SHOWN



VIEW A-A (90°)
TYPICAL MOUNTING FOR R110-R116 & R118, R120-R124



VIEW B-B

6. MOUNT R55, R102 & R137 .12 OFF BOARD.
▷ APPLY THERMATE SILICONE COMPOUND UNDER ALL COMPONENTS ON HEATSINKS.
▷ DO NOT INSTALL MOUNTING SCREWS IN ITEM 276 UNTIL AFTER ASSEMBLING HEATSINK TO P.C. BOARD.
▷ SWAGE TERMINALS F.S. USING USECO TOOL #2010 OR EQUIV.
▷ SOLDER HEATSINK TO BOARD ON PADS PROVIDED.
L FOR SCHEMATIC DIAGRAM SEE DWG 1120-070.

NOTES: (UNLESS OTHERWISE SPECIFIED)

FOR PARTS LIST SEE PL 1120-700-1, -2

REQD PER ASSY	ITEM NO	PART NUMBER	PART NAME	MATERIAL — SPECIFICATION	CODE IDENT	FINISH	REF DES	ZONE
			-2 PC BD ASSY					
			-1 PC BD ASSY					

DIM IN INCHES TOLERANCES .XX = ±.01 .XXX = ±.005 BREAK ALL SHARP CORNERS & EDGE MAKE SURFACES

DWG D 6-71

TITLE P.C. BOARD ASSEMBLY A1

CALICO

MODEL LC 1201A / LC 1201B

CONTRACT NO. 16067

DWG NO. 1120-700 REV T

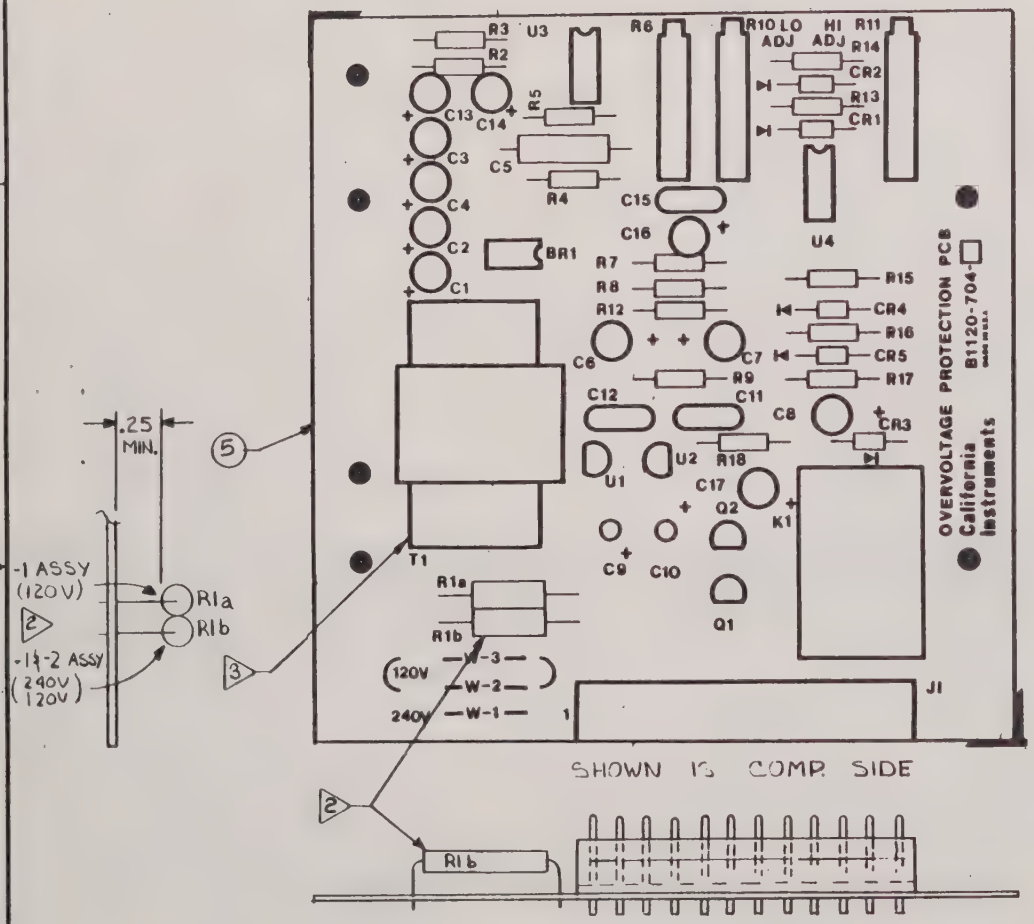
SCALE 1/1 SHEET 1 OF 2

DRAWN LC 1201B 7/66 CHECKED P.C. 7/66 DESIGN 7/66 ENGR APPROVED B.J. SUPERVISOR 7/11 DATE 7/66

REVISIONS

REV	AUTH	DESCRIPTION	ZONE	EFF ON	DATE	APPD
T		ADDED -2 ASSY				

REVISIONS						
REV	AUTH	DESCRIPTION	ZONE	EFF ON	DATE	APRD
		SEE SHEET ONE				



WIRE TAB TABLE

W1 → ADD TO 1120-704-2 ASSY ONLY (240V)

W2, W3 } ADD TO 1120-704-1 ASSY ONLY (120V)

ITEM NO.	PART NUMBER	PART NAME	MATERIAL — SPECIFICATION	CODE IDENT	FINISH	REF DES.	ZONE
REQD PER ASSY			SEE PARTS LIST SHT 4 ↕ 5				

3> BLACK DOT ON LABEL OF TRANSFORMER INDICATES PIN ONE.

2> MOUNT R1 MIN. OF .25 OFF P.C.B.

1. SCHEMATIC DWG = C1120-078.

DIM IN INCHES TOLERANCES XXX = .010 XX = .03 X° = 30'

BREAK ALL SHARP CORNERS & EDGES MACH SURFACES

DWG SIZE C

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TITLE: P.C. BOARD ASSY. - OVERVOLTAGE PROTECTION CIRCUIT

MODEL	LC1201B / 1360			
RELEASE	J. Kirby	2-6-80	A. Duckett	2/5/80
CHECKER	G. ZIELSTORF	2-4-80	PURCHASING	
DESIGN			PROJ ENGR	

CALIFORNIA INSTRUMENTS a division of ACME ELECTRONICS INC.

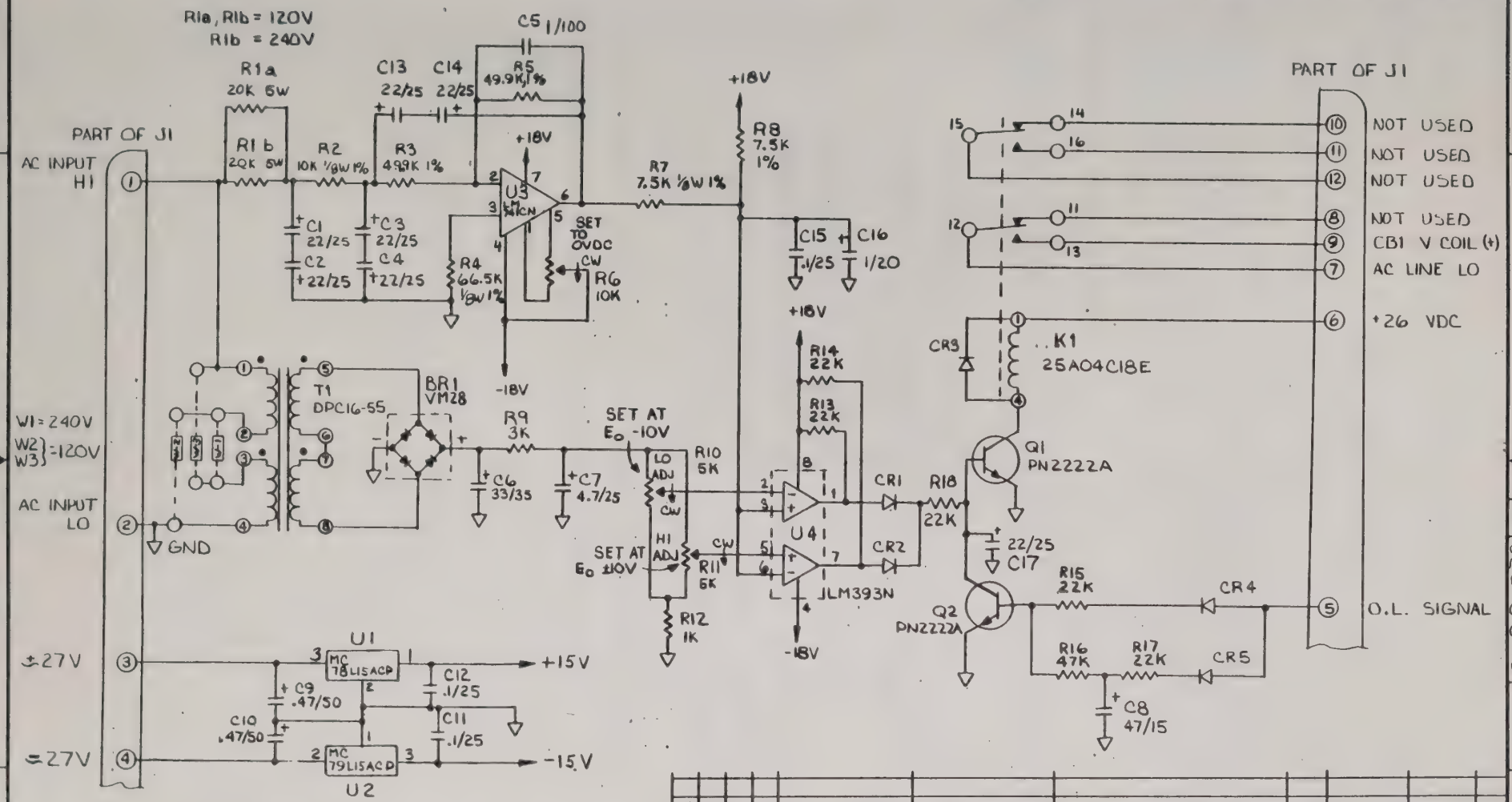
CONTRACT NO. –

CODE IDENT 16067

DWG NO. C1120-704

REV C

REV	AUTH	DESCRIPTION	ZONE	EFF ON	DATE	APRD
A	ECO 956	SEE ECO 956 RM 4/15/80			4/16/80	MCD
B	ECO	ECO 980 AB 10/80			10/30/80	MB



6. LAST REF DESIG USED: XFORMER - T1 RELAY - K1
   RES - R18 DIODE - CR5 TRANS - Q2 WIRE - W3
   CAP - C17 I.C. - U4 BRIDGE - BR1 CONN - J1
5. THIS SCHEMATIC IS A REFERENCE DWG. FOR SPECIFIC PARTS USED SEE PARTS LIST OF SPECIFIC MODEL.
4. ALL DIODES IN4148.
3. ALL CAPACITORS, MICROFARADS / VOLTAGE.
2. ALL RESISTORS ARE IN OHMS, 1/4W, 5%
1. FOR ASSY DWG SEE C1120-104.

NOTES: (UNLESS OTHERWISE SPECIFIED)

ITEM NO.	PART NUMBER	PART NAME	MATERIAL — SPECIFICATION	CODE IDENT	FINISH	REF DES.	ZONE
REQD PER ASSY							

DIM IN INCHES TOLERANCES XXX = .010 XX = .03 X° = 30'
BREAK ALL SHARP CORNERS & EDGES MACH SURFACES
DWG SIZE C

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TITLE SCHEMATIC, OVERVOLTAGE PROTECTION CIRCUIT

CALIFORNIA INSTRUMENTS a division of CALICO INDUSTRIES, INC.

MODEL	LC12018 / 1360			CONTRACT NO.	CODE IDENT 16067
RELEASE	L. Kurtz	2-6-80			
CHECKER	G. ZIELSTORF	2-4-80	PURCHASING	DWG NO. C1120-078	REV B
DESIGN			PROJ ENGR		
DRFTSMN	Robb M	11/79	CHF ENGR	SCALE NONE	SHEET 1 OF 1

DASH NO.	QTY REQD	NEXT ASSEMBLY	EFF ON	AUTH

SECTION IX

REPLACEABLE PARTS

9.1 GENERAL

This section contains ordering information and a complete list of replaceable parts. The parts are listed by their major assembly in alpha-numeric order by their reference designators. The list includes the parts description, manufacturers' identification (see Appendix A for list of manufacturers), and California Instruments' part numbers.

9.2 ORDERING INFORMATION

In order to ensure prompt, accurate service, please provide the following information, when applicable, for each replacement part ordered.

a. Model number and serial number of the instrument.

b. California Instruments part number for the sub-assembly where component is located (PARENT ITEM NO.).

c. Component reference designator (SEQ NO.).

d. Component description (DESCRIPTION TRUNCATED).

e. Component manufacturer's FSCM number (VENDOR).

f. California Instruments part number (COMPONENT ITEM NO.).

A further explanation of these terms can be found in Section 9.3.

All replacement part orders should be addressed to:

California Instruments
Attention: Parts Department
5150 Convoy Street
San Diego, California 92111-1266

9.3 COMPUTER GENERATED PARTS LISTS

The following information is included as an explanation of the computer formatted parts list column.

9.3.1 "SEQ NO." - Sequence Number: the reference designator or the component, or (if there is no reference designator) the balloon number (bubble or "find" number) on the face of the assembly drawing or the top assembly drawing. They are listed in alpha-numeric order.

9.3.2 "COMPONENT ITEM NO." - This is California Instruments' part number. Please use this number when ordering spares or replacements.

9.3.3 "DESCRIPTION TRUNCATED" - A brief description of the item. The abbreviations are per MIL-STD-12 or industry accepted standards.

9.3.4 "ENGINEERING DRAWING NUMBER" - This is used for one of the following:

a. The document/specification number generated by California Instruments to control the part.

b. The generic part number (military specifications or industry accepted standard).

c. The primary vendor's catalog part number. An asterisk at the end of the number indicates number is longer than that shown. (Contact California Instruments if the full number is required.)

9.3.5 "VENDOR" - This is the FSCM code to identify the manufacturer. (See Appendix A).

9.3.6 "QTY" - This is the Quantity and Unit of Measure used in the assembly. The Unit of Measure abbreviations are per MIL-STD-12 or industry accepted standard.

SEQ NO.	COMPONENT ITEM NO.	DESCRIPTION TRUNCATED	ENGINEERING DRAWING NO.	VENDOR	QTY	UM
	1120-050-0	HARNESS ASSY,JUMPER	1120-050 REV K	16067	1.0	EA
	1120-050-1	HARNESS ASSY,SHIELDED	1120-050 REV K	16067	1.0	EA
	1120-050-2	HARNESS ASSY	1120-050 REV K	16067	1.0	EA
A1	1120-700-1	PC ASSY,AMPLIFIER	1120-700 REV S1	16067	1.0	EA
A2	1120-704-1	PC ASSY,OVERVOLT PROT	1120-704 REV D3	16067	1.0	EA
B1	241063	FAN,4",115VAC,50/60HZ	WS2107F-110	99743	1.0	EA
CB1	270089	CIRCUIT BREAKER,20A,120V	AM1-A16-A-20-3	74193	1.0	EA
CR1	310232	BRDG,RECT,FW 30A,200V	MDA990-3	04713	1.0	EA
C1	610821	CAP,CER,.1UF,500V	5HK-P10	56289	1.0	EA
C2	610930	CAP,AC,5UF,236V	OP536	90201	1.0	EA
C3	611095	CAP,AC,10UF,250V	W45C2510E	35007	1.0	EA
C4	610891	CAP,AL,10000UF,75V	DCM103U075BC2B	00853	1.0	EA
C5	610891	CAP,AL,10000UF,75V	DCM103U075BC2B	00853	1.0	EA
DS1	241021	LAMP,GAS,AMBER,120V	BG03ACSNE2H/33K	03797	1.0	EA
DS2	241023	LAMP,INCAND,28V,RED	BF03RCS1762	03797	1.0	EA
J2	241073	CONN,AC RCPT,3W,DUP,125V	5252	74545	1.0	EA
L1	590058	INDUCTOR,400UH,15A,EI625	1120-012	16067	1.0	EA
M1	CIC800	METER,DC,ANLG,MA,0-1	CIC800-0	16067	1.0	EA
M1	CIC800-21	MTR FACE,MTL,W/1120-101	CIC800/4995-285	16067	1.0	EA
P1	241078	PWR CORD,115V,14-3,6' W/	14-3-SJT	0000A	1.0	EA
R1	550203	RES,PWR,3W,.2 OHM	RW69VR20	81349	1.0	EA
R2	550189	RES,PWR,50W,.01 OHM,1%	RH-50-73-.01	91637	1.0	EA
R3	520077	RES,CARB,1/2W,100K OHM	RC20GF104J	81349	1.0	EA
S1	241169	SWITCH,RTRY,DP,5POS/PWR	111-3	44655	1.0	EA
T1	710260	TRANSFORMER,INPUT	1120-010-1	16067	1.0	EA
1	FS3008	MOUNTING CRADLE,WIRE TIE	WTMC-1	51705	2.0	EA
2	FS3010	WIRE TIE,51/2	WRN-51/2	51705	2.0	EA
48	210501	DECAL,VOLTAGE RANGE	1120-102-7	16067	1.0	EA
49	110433-1	PANEL,FRONT W/1120-200	1120-200-1	16067	1.0	EA
50	110434	SIDE RAIL,RIGHT	1120-201-7	16067	1.0	EA
51	110435	SIDE RAIL,LEFT	1120-202-8	16067	1.0	EA
52	110436-15	NMPLT W/1120-100	1120-207-15	16067	1.0	EA
53	110776	STANDOFF,1/4-20 X 41/2"	1120-208-7	16067	2.0	EA
55	110368	COVER,TOP & BOTTOM	4050-225-7	16067	2.0	EA
56	110468	PANEL,REAR	1120-203-7	16067	1.0	EA
57	210361	STRAIN RELIEF	SR-7P-2	28520	1.0	EA
58	240225	HANDLE,FLT,S/S,4-9/16"	11519-S-0832-4	06540	2.0	EA
60	210191	KNOB,BLK,IND	PS-70D-2-BLK	21604	1.0	EA
61	610717	CAP CLAMP,2"	4586-48	56289	2.0	EA
62	240237	KNOB,BLK,LG POINTER	PS-95PL-2-BLK	21604	1.0	EA
63	210091	NUT,SPEED,6-32	C8020-632	78553	12.0	EA
64	210712	SCREW,CTG,PNH,6-20X1/2	MS51861-25	96906	8.0	EA
65	210063	STANDOFF,6-32 X 1/2"	2322	83330	4.0	EA
66	210105	GROMMET,RUBBER,5/16"DIA	2172	83330	1.0	EA
67	610955	CAP CLAMP,1-5/16X2-5/32"	08-2	90201	1.0	EA
68	241064	FAN GUARD	550481	82877	1.0	EA
69	210024	SCREW,DRS,(U),CAD,00X1/8	#00X1/8 TYPE B	45722	2.0	EA

SEQ NO.	COMPONENT ITEM NO.	DESCRIPTION TRUNCATED	ENGINEERING DRAWING NO.	VENDOR	QTY	UN
70	250083	TERMINAL STRP, 1TERM,1MT	849	83330	1.0	EA
72	FS3004	CABLE CLAMP,1/4"ID	CLE-1/4	51705	1.0	EA
73	FS1013	SCREW,PNH,S/S,4-40X3/8	MS51957-15	96906	3.0	EA
74	FS1001	SCREW,FLH,S/S,6-32X5/16	MS24693-C25	81349	2.0	EA
75	FS1068	WASHER,INTER,S/S,#4	MS35333-70	81349	3.0	EA
76	FS1066	NUT,HEX,S/S,4-40	MS35649-244	96906	3.0	EA
77	FS1027	SCREW,FLH,S/S,6-32X1/4	MS24693-C24	96906	27.0	EA
79	FS1028	SCREW,PNH,S/S,6-32X5/16	MS51957-27	81349	13.0	EA
80	FS1034	SCREW,PNH,S/S,6-32X5/8	MS51957-31	96906	12.0	EA
84	FS1069	WASHER,INTER,S/S,#6	MS35333-71	96906	17.0	EA
85	FS1073	WASHER,SPLT,S/S,#6	MS35338-136	96906	15.0	EA
86	FS1080	WASHER,FLAT,S/S,#6	MS15795-806	96906	10.0	EA
87	FS1064	NUT,HEX,S/S,6-32	MS35649-264	96906	23.0	EA
89	FS1042	SCREW,PNH,S/S,8-32X3/8	MS51957-43	96906	8.0	EA
90	FS1044	SCREW,FLH,S/S,8-32X1/2	MS24693-C50	81349	4.0	EA
91	FS1070	WASHER,INTER,S/S,#8	MS35333-72	81349	13.0	EA
93	FS1065	NUT,HEX,S/S,8-32	MS35649-284	96906	9.0	EA
94	FS1081	WASHER,FLAT,S/S,#8	MS15795-841	96906	1.0	EA
95	210233	BOLT,HEX,S/S,10-32X1/2	MS9489-06	96906	12.0	EA
96	FS1045	SCREW,PNH,S/S,8-32X1/2	MS51957-45	81349	5.0	EA
98	FS1075	WASHER,SPLT,S/S,#10	MS35338-138	96906	12.0	EA
100	FS1067	NUT,HEX,S/S,10-32	MS35650-304	96906	12.0	EA
103	210271	BOLT,HEX,S/S,1/4-20X1/2	MS35307-303	96906	2.0	EA
104	210220	BOLT,HEX,S/S,1/4-20X3/4	MS35307-306	96906	4.0	EA
105	210097	WASHER,FLAT,1/4	MS15795-810	96906	10.0	EA
106	210459	WASHER,SPLT,1/4	MS35338-139	96906	6.0	EA
107	210298	NUT,HEX,S/S,1/4-20	MS35649-2254	96906	4.0	EA

SEQ NO.	COMPONENT ITEM NO.	DESCRIPTION TRUNCATED	ENGINEERING DRAWING NO.	VENDOR	QTY	UM
1	FS2012	LUG,RING,CRIMP,12/10-10	R4170F	14726	1.0	EA

SEQ NO.	COMPONENT ITEM NO.	DESCRIPTION TRUNCATED	ENGINEERING DRAWING NO.	VENDOR	QTY	UM
P2	410292	CONN,PC HSG,12 PIN	09-50-3121	27264	1.0	EA
1	410293	TERMINAL,CRIMP	08-56-0105	27264	8.0	EA
2	FS2022	LUG,RING,CRIMP,26/24-10	XR26340	14726	1.0	EA
3	FS2001	LUG,RING,CRIMP,22/18-10	R4149SF	14726	5.0	EA
4	FS2007	LUG,S/O,F,CRMP,22/18-1/4	S09615SF	14726	3.0	EA
5	FS2006	LUG,RING,CRIMP,16/14-6	R61005GSF	14726	1.0	EA
6	FS2005	LUG,RING,CRIMP,16/14-10	R4161F	14726	5.0	EA
7	FS2016	LUG,SPADE,CRIMP,16/14-10	SS22533F	14726	2.0	EA
8	FS2019	LUG,S/O,F,CRMP,16/14-1/4	S09718SF	14726	1.0	EA
9	FS2012	LUG,RING,CRIMP,12/10-10	R4170F	14726	5.0	EA
10	FS2008	LUG,SPADE,CRIMP,12/10-10	SS22567F	14726	2.0	EA

SEQ NO.	COMPONENT ITEM NO.	DESCRIPTION TRUNCATED	ENGINEERING DRAWING NO.	VENDOR	QTY	UN
CR1	310118	DIODE,SWNG,75V,.5W,DO35	1N914	07263	1.0	EA
CR2	310118	DIODE,SWNG,75V,.5W,DO35	1N914	07263	1.0	EA
CR3	310118	DIODE,SWNG,75V,.5W,DO35	1N914	07263	1.0	EA
CR4	310189	DIODE,REF,6.3V,.001%TC	CIC702-7	16067	1.0	EA
CR5	310118	DIODE,SWNG,75V,.5W,DO35	1N914	07263	1.0	EA
CR6	310118	DIODE,SWNG,75V,.5W,DO35	1N914	07263	1.0	EA
CR7	310118	DIODE,SWNG,75V,.5W,DO35	1N914	07263	1.0	EA
CR9	310136	DIODE,ZNR,3.6V,.5W,10%	1N5227A	04713	1.0	EA
CR10	310062	DIODE,RECT,1A,400V,DO41	1N4004	81349	1.0	EA
CR11	310062	DIODE,RECT,1A,400V,DO41	1N4004	81349	1.0	EA
CR12	310062	DIODE,RECT,1A,400V,DO41	1N4004	81349	1.0	EA
CR13	310062	DIODE,RECT,1A,400V,DO41	1N4004	81349	1.0	EA
CR14	310173	DIODE,ZNR,16V,.5W,5%	1N5246B	04713	1.0	EA
CR15	310173	DIODE,ZNR,16V,.5W,5%	1N5246B	04713	1.0	EA
CR16	310118	DIODE,SWNG,75V,.5W,DO35	1N914	07263	1.0	EA
CR17	310118	DIODE,SWNG,75V,.5W,DO35	1N914	07263	1.0	EA
CR18	310118	DIODE,SWNG,75V,.5W,DO35	1N914	07263	1.0	EA
CR19	FS5119	WIRE,BUS,AWG 22,QQ-W-343E	QQW343S22S2B	81348	1.0	IN
CR20	310062	DIODE,RECT,1A,400V,DO41	1N4004	81349	1.0	EA
CR21	FS5119	WIRE,BUS,AWG 22,QQ-W-343E	QQW343S22S2B	81348	1.0	IN
CR22	310118	DIODE,SWNG,75V,.5W,DO35	1N914	07263	1.0	EA
CR23	310226	DIODE,RECT,15A,200V,DO5	1N3210	04713	1.0	EA
CR24	310226	DIODE,RECT,15A,200V,DO5	1N3210	04713	1.0	EA
CR25	310118	DIODE,SWNG,75V,.5W,DO35	1N914	07263	1.0	EA
CR26	310118	DIODE,SWNG,75V,.5W,DO35	1N914	07263	1.0	EA
CR27	310118	DIODE,SWNG,75V,.5W,DO35	1N914	07263	1.0	EA
CR28	310118	DIODE,SWNG,75V,.5W,DO35	1N914	07263	1.0	EA
C1	610127	CAP,CER,.1UF,100V	TG-P10	56289	1.0	EA
C2	610738	CAP,TANT,10UF,25V	T362A106M025AS	05397	1.0	EA
C3	610127	CAP,CER,.1UF,100V	TG-P10	56289	1.0	EA
C4	610761	CAP,TANT,1UF,20V	T362A105M020AS	05397	1.0	EA
C5	610263	CAP,MICA,30PF,500V	CM05E300J03	81349	1.0	EA
C6	610577	CAP,MYLAR,.47UF,100V	1DP-4-474	72136	1.0	EA
C7	610127	CAP,CER,.1UF,100V	TG-P10	56289	1.0	EA
C8	610907	CAP,PC,1UF,50V,1%	BA2C105F	27556	1.0	EA
C9	610907	CAP,PC,1UF,50V,1%	BA2C105F	27556	1.0	EA
C10	610796	CAP,TANT,1UF,35V	T362A105M035AS	05397	1.0	EA
C11	610127	CAP,CER,.1UF,100V	TG-P10	56289	1.0	EA
C12	610863	CAP,TANT,100UF,20V	T362D107M020AS	05397	1.0	EA
C13	610907	CAP,PC,1UF,50V,1%	BA2C105F	27556	1.0	EA
C14	610907	CAP,PC,1UF,50V,1%	BA2C105F	27556	1.0	EA
C15	610127	CAP,CER,.1UF,100V	TG-P10	56289	1.0	EA
C16	610395	CAP,AL,250UF,50V	WBR250-50	14655	1.0	EA
C17	610395	CAP,AL,250UF,50V	WBR250-50	14655	1.0	EA
C18	610751	CAP,TANT,33UF,10V	T362B336M010AS	05397	1.0	EA
C19	610566	CAP,MYLAR,.22UF,100V	1DP-3-224	72136	1.0	EA
C20	610127	CAP,CER,.1UF,100V	TG-P10	56289	1.0	EA

SEQ NO.	COMPONENT ITEM NO.	DESCRIPTION TRUNCATED	ENGINEERING DRAWING NO.	VENDOR	QTY
C21	FS7002	CAP,TBD	TBD	31349	1.0
C22	610055	CAP,CER,2000PF,1000V	DD202	71590	1.0
C23	610781	CAP,TANT,.47UF,50V	T362A474M050AS	05397	1.0
C24	610062	CAP,CER,1000PF,1000V	5HK-D10	56289	1.0
C25	610197	CAP,AL,1CUF,100V	TE1407	56289	1.0
C26	610062	CAP,CER,1000PF,1000V	5HK-D10	56289	1.0
C27	610853	CAP,PC,10UF,100V-10KHZ	625B1B106M	12406	1.0
C28	610738	CAP,TANT,10UF,25V	T362A106M025AS	05397	1.0
C29	FS7002	CAP,TBD	TBD	81349	1.0
C30	610127	CAP,CER,.1UF,100V	TG-P10	56289	1.0
C31	610863	CAP,TANT,100UF,20V	T362D107M020AS	05397	1.0
C32	610321	CAP,MYLAR,1UF,400V	ZD4A105	12406	1.0
C33	610197	CAP,AL,10UF,100V	TE1407	56289	1.0
C36	611041	CAP,PC,.15UF,200V,1%	BA2C154F	27556	1.0
E35	250315	TERMINAL,QCK CLP,PB,MALE	836	79963	2.0
E36	250315	TERMINAL,QCK CLP,PB,MALE	836	79963	1.0
E37	250315	TERMINAL,QCK CLP,PB,MALE	836	79963	1.0
E38	250315	TERMINAL,QCK CLP,PB,MALE	836	79963	1.0
IC1	360030	IC,OP-AMP,GP,COMPENSATED	LM741CN	27014	1.0
IC2	360030	IC,OP-AMP,GP,COMPENSATED	LM741CN	27014	1.0
IC3	360029	IC,OP-AMP,GP	LM201AN	27014	1.0
IC4	330006	IC,OP-AMP	CIC200-2	16067	1.0
IC5	360030	IC,OP-AMP,GP,COMPENSATED	LM741CN	27014	1.0
IC6	360030	IC,OP-AMP,GP,COMPENSATED	LM741CN	27014	1.0
IC7	360030	IC,OP-AMP,GP,COMPENSATED	LM741CN	27014	1.0
IC8	360030	IC,OP-AMP,GP,COMPENSATED	LM741CN	27014	1.0
IC9	360030	IC,OP-AMP,GP,COMPENSATED	LM741CN	27014	1.0
IC10	360040	IC,OP-AMP,FET,GP	NE536T	18324	1.0
IC11	360030	IC,OP-AMP,GP,COMPENSATED	LM741CN	27014	1.0
IC12	360006	IC,OP-AMP	CIC200-3	16067	1.0
IC13	360030	IC,OP-AMP,GP,COMPENSATED	LM741CN	27014	1.0
IC14	360030	IC,OP-AMP,GP,COMPENSATED	LM741CN	27014	1.0
IC15	360048	IC,MOS,NAND,3-IN,TRIPLE	CD4023AE	86684	1.0
Q1	330206	TRANSISTOR,SS,NPN,TO92	2N4124	81349	1.0
Q2	330196	TRANSISTOR,FET,N,JFET	U1899E	15818	1.0
Q3	330251	TRANSISTOR,ARRAY,FET,DIP	CD4007AE	95303	1.0
Q4	330241	TRANSISTOR,PWR,NPN,TO220=	TIP29A	01295	1.0
Q5	330250	TRANSISTOR,PWR,PNP,TO220=	TIP30A	01295	1.0
Q6	330252	TRANSISTOR,ARRAY,N/P,DIP	CA3096AE	95303	1.0
Q7	330106	TRANSISTOR,SS,PNP,TO39	2N4036	04713	1.0
Q8	330106	TRANSISTOR,SS,PNP,TO39	2N4036	04713	1.0
Q9	330122	THYR TRIAC,2.5A,100V,TO5=	T2300A	02375	1.0
Q10	330090	TRANSISTOR,SS,NPN,TO39	2N3440	81349	1.0
Q11	330141	TRANSISTOR,SS,PNP,TO5	2N5415	95303	1.0
Q12	330140	TRANSISTOR,PWR,NPN,TO3	61412 (2N3773)	86684	1.0
Q13	330140	TRANSISTOR,PWR,NPN,TO3	61412 (2N3773)	86684	1.0
Q14	330140	TRANSISTOR,PWR,NPN,TO3	61412 (2N3773)	86684	1.0

SEQ NO.	COMPONENT ITEM NO.	DESCRIPTION TRUNCATED	ENGINEERING DRAWING NO.	VENDOR	QTY	U
Q15	330140	TRANSISTOR,PWR,NPN,TO3	61412 (2N3773)	86684	1.0	E
Q16	330140	TRANSISTOR,PWR,NPN,TO3	61412 (2N3773)	86684	1.0	E
Q17	330140	TRANSISTOR,PWR,NPN,TO3	61412 (2N3773)	86684	1.0	E
Q18	330090	TRANSISTOR,SS,NPN,TO39	2N3440	81349	1.0	E
Q19	330140	TRANSISTOR,PWR,NPN,TO3	61412 (2N3773)	86684	1.0	E
Q20	330140	TRANSISTOR,PWR,NPN,TO3	61412 (2N3773)	86684	1.0	E
Q21	330140	TRANSISTOR,PWR,NPN,TO3	61412 (2N3773)	86684	1.0	E
Q22	330140	TRANSISTOR,PWR,NPN,TO3	61412 (2N3773)	86684	1.0	E
Q23	330140	TRANSISTOR,PWR,NPN,TO3	61412 (2N3773)	86684	1.0	E
Q24	330140	TRANSISTOR,PWR,NPN,TO3	61412 (2N3773)	86684	1.0	E
Q25	330219	TRANSISTOR,SS,NPN,TO92	2N5172	81349	1.0	E
Q26	330169	THYR TRIAC,40A,200V,TO48	2N5444	02375	1.0	E
Q27	330216	TRANSISTOR,SS,NPN,TO92	MPSA14	04713	1.0	E
Q28	330216	TRANSISTOR,SS,NPN,TO92	MPSA14	04713	1.0	E
Q29	330216	TRANSISTOR,SS,NPN,TO92	MPSA14	04713	1.0	E
R1	510125	RES,CARB,1/4W,1.8M OHM	RC07GF185J	81349	1.0	E
R2	570217	POT,1T,PC,10K	X201R103B	71450	1.0	E
R3	510076	RES,CARB,1/4W,10K OHM	RC07GF103J	81349	1.0	E
R4	560414	RES,FILM,1/4W,12.1K,1%	RN60C1212F	81349	1.0	E
R5	510100	RES,CARB,1/4W,100K OHM	RC07GF104J	81349	1.0	E
R6	510076	RES,CARB,1/4W,10K OHM	RC07GF103J	81349	1.0	E
R7	510100	RES,CARB,1/4W,100K OHM	RC07GF104J	81349	1.0	E
R8	510076	RES,CARB,1/4W,10K OHM	RC07GF103J	81349	1.0	E
R9	510076	RES,CARB,1/4W,10K OHM	RC07GF103J	81349	1.0	E
R10	510100	RES,CARB,1/4W,100K OHM	RC07GF104J	81349	1.0	E
R11	510076	RES,CARB,1/4W,10K OHM	RC07GF103J	81349	1.0	E
R12	560649	RES,FILM,1/4W,22.1K,1%	RN60E2212F	81349	1.0	E
R13	510069	RES,CARB,1/4W,5.1K OHM	RC07GF512J	81349	1.0	E
R14	510100	RES,CARB,1/4W,100K OHM	RC07GF104J	81349	1.0	E
R15	510076	RES,CARB,1/4W,10K OHM	RC07GF103J	81349	1.0	E
R16	560650	RES,FILM,1/4W,5.9K,1%	RN60E5901F	81349	1.0	E
R17	570218	POT,MT,PC,1K	3299W-1-102	80294	1.0	E
R18	560651	RES,FILM,1/4W,3.32K,1%	RN60E3321F	81349	1.0	E
R19	510076	RES,CARB,1/4W,10K OHM	RC07GF103J	81349	1.0	E
R20	560238	RES,FILM,1/4W,4.99K,1%	RN60C4991F	81349	1.0	E
R21	560475	RES,FILM,1/4W,124 OHM,1%	RN60C1240F	81349	1.0	E
R22	510046	RES,CARB,1/4W,510 OHM	RC07GF511J	81349	1.0	E
R23	510100	RES,CARB,1/4W,100K OHM	RC07GF104J	81349	1.0	E
R24	560253	RES,FILM,1/4W,48.7K,1%	RN60C4872F	81349	1.0	E
R25	510092	RES,CARB,1/4W,47K OHM	RC07GF473J	81349	1.0	E
R26	510100	RES,CARB,1/4W,100K OHM	RC07GF104J	81349	1.0	E
R27	570177	POT,1T,PC,2.5K,1/4W	X201R252B	71450	1.0	E
R28	560487	RES,FILM,1/4W,511 OHM,1%	RN60C5110F	81349	1.0	E
R29	560081	RES,FILM,1/4W,10K,1%	RN60C1002F	81349	1.0	E
R30	560081	RES,FILM,1/4W,10K,1%	RN60C1002F	81349	1.0	E
R31	510080	RES,CARB,1/4W,15K OHM	RC07GF153J	81349	1.0	E
R32	560410	RES,FILM,1/4W,5.62K,1%	RN60C5621F	81349	1.0	E

SEQ NO.	COMPONENT ITEM NO.	DESCRIPTION TRUNCATED	ENGINEERING DRAWING NO.	VENDOR	QTY	UM
R33	510076	RES,CARB,1/4W,10K OHM	RC07GF103J	81349	1.0	EA
R34	560485	RES,FILM,1/4W,10K,1%	RN60E1002F	81349	1.0	EA
R35	560653	RES,FILM,1/4W,4.99K,1%	RN60E4991F	81349	1.0	EA
R36	560479	RES,FILM,1/4W,147 OHM,1%	RN60C1470F	81349	1.0	EA
R37	560481	RES,FILM,1/4W,16.2K,1%	RN60C1622F	81349	1.0	EA
R38	560654	RES,FILM,1/4W,53.6K,1%	RN60C5361F	81349	1.0	EA
R39	510094	RES,CARB,1/4W,56K OHM	RC07GF563J	81349	1.0	EA
R40	560485	RES,FILM,1/4W,10K,1%	RN60E1002F	81349	1.0	EA
R41	510067	RES,CARB,1/4W,4.3K OHM	RC07GF432J	81349	1.0	EA
R42	510068	RES,CARB,1/4W,4.7K OHM	RC07GF472J	81349	1.0	EA
R43	560655	RES,FILM,1/4W,30.1K,1%	RN60C3012F	81349	1.0	EA
R44	560004	RES,FILM,1/4W,100 OHM,1%	RN60C1000F	81349	1.0	EA
R45	570156	POT,1T,PC,5K,1/4W	X201R502B	71450	1.0	EA
R46	560485	RES,FILM,1/4W,10K,1%	RN60E1002F	81349	1.0	EA
R47	560655	RES,FILM,1/4W,30.1K,1%	RN60C3012F	81349	1.0	EA
R48	510005	RES,CARB,1/4W,10 OHM	RC07GF100J	81349	1.0	EA
R49	510053	RES,CARB,1/4W,1K OHM	RC07GF102J	81349	1.0	EA
R50	510053	RES,CARB,1/4W,1K OHM	RC07GF102J	81349	1.0	EA
R51	510005	RES,CARB,1/4W,10 OHM	RC07GF100J	81349	1.0	EA
R55	550007	RES,PWR,3-1/4W,5 OHM,5%	4349	44655	1.0	EA
R56	570218	POT,MT,PC,1K	3299W-1-102	80294	1.0	EA
R57	FS7000	RES,CARB,1/4W,TBD	RC07GF...	81349	1.0	EA
R58	570217	POT,1T,PC,10K	X201R103B	71450	1.0	EA
R59	560656	RES,FILM,1/4W,232K,1%	RN60E2323F	81349	1.0	EA
R60	560657	RES,FILM,1/4W,9.53K,1%	RN60E9531F	81349	1.0	EA
R61	560131	RES,FILM,1/4W,100K,1%	RN60C1003F	81349	1.0	EA
R62	560004	RES,FILM,1/4W,100 OHM,1%	RN60C1000F	81349	1.0	EA
R63	560516	RES,FILM,1/4W,36.5K,1%	RN60C3652F	81349	1.0	EA
R64	570153	POT,1T,PC,100 OHM,1/4W	X201R101B	71450	1.0	EA
R65	560004	RES,FILM,1/4W,100 OHM,1%	RN60C1000F	81349	1.0	EA
R66	510076	RES,CARB,1/4W,10K OHM	RC07GF103J	81349	1.0	EA
R67	560131	RES,FILM,1/4W,100K,1%	RN60C1003F	81349	1.0	EA
R68	510044	RES,CARB,1/4W,430 OHM	RC07GF431J	81349	1.0	EA
R69	560533	RES,FILM,1/4W,825 OHM,1%	RN60C8250F	81349	1.0	EA
R70	510060	RES,CARB,1/4W,2.2K OHM	RC07GF222J	81349	1.0	EA
R71	510076	RES,CARB,1/4W,10K OHM	RC07GF103J	81349	1.0	EA
R72	560533	RES,FILM,1/4W,825 OHM,1%	RN60C8250F	81349	1.0	EA
R73	510051	RES,CARB,1/4W,820 OHM	RC07GF821J	81349	1.0	EA
R74	560533	RES,FILM,1/4W,825 OHM,1%	RN60C8250F	81349	1.0	EA
R75	560427	RES,FILM,1/4W,5.11K,1%	RN60C5111F	81349	1.0	EA
R76	560487	RES,FILM,1/4W,511 OHM,1%	RN60C5110F	81349	1.0	EA
R77	560487	RES,FILM,1/4W,511 OHM,1%	RN60C5110F	81349	1.0	EA
R78	560659	RES,FILM,1/4W,4.32K,1%	RN60C4321F	81349	1.0	EA
R79	560427	RES,FILM,1/4W,5.11K,1%	RN60C5111F	81349	1.0	EA
R80	510076	RES,CARB,1/4W,10K OHM	RC07GF103J	81349	1.0	EA
R81	570157	POT,1T,PC,100K,1/4W	X201R104B	71450	1.0	EA
R82	510084	RES,CARB,1/4W,22K OHM	RC07GF223J	81349	1.0	EA

SEQ NO.	COMPONENT ITEM NO.	DESCRIPTION TRUNCATED	ENGINEERING DRAWING NO.	VENDOR	QTY
R83	510044	RES,CARB,1/4W,430 OHM	RC07GF431J	81349	1.0
R84	510078	RES,CARB,1/4W,12K OHM	RC07GF123J	81349	1.0
R85	510044	RES,CARB,1/4W,430 OHM	RC07GF431J	81349	1.0
R86	510063	RES,CARB,1/4W,3.0K OHM	RC07GF302J	81349	1.0
R87	560213	RES,FILM,1/4W,412 OHM,1%	RN60C4120F	81349	1.0
R88	510118	RES,CARB,1/4W,620K OHM	RC07GF624J	81349	1.0
R89	510043	RES,CARB,1/4W,390 OHM	RC07GF391J	81349	1.0
R90	510037	RES,CARB,1/4W,220 OHM	RC07GF221J	81349	1.0
R91	560419	RES,FILM,1/4W,715 OHM,1%	RN60C7150F	81349	1.0
R92	560232	RES,FILM,1/4W,40.2K,1%	RN60C4022F	81349	1.0
R93	510100	RES,CARB,1/4W,100K OHM	RC07GF104J	81349	1.0
R94	510053	RES,CARB,1/4W,1K OHM	RC07GF102J	81349	1.0
R95	510080	RES,CARB,1/4W,15K OHM	RC07GF153J	81349	1.0
R96	570155	POT,1T,PC,500 OHM,1/4W	X201R501B	71450	1.0
R97	560342	RES,FILM,1/4W,1K,1%	RN60C1001F	81349	1.0
R98	560561	RES,FILM,1/4W,6.81K,1%	RN60C6811F	81349	1.0
R99	510075	RES,CARB,1/4W,9.1K OHM	RC07GF912J	81349	1.0
R100	510067	RES,CARB,1/4W,4.3K OHM	RC07GF432J	81349	1.0
R101	510051	RES,CARB,1/4W,820 OHM	RC07GF821J	81349	1.0
R102	550010	RES,PWR,3W,.5 OHM,3%	RS-2B-.5 OHM	91637	1.0
R103	510110	RES,CARB,1/4W,270K OHM	RC07GF274J	81349	1.0
R104	560660	RES,FILM,1/4W,1.78K,1%	RN60C1781F	81349	1.0
R105	570130	POT,1T,PC,1K	X201R102B	71450	1.0
R106	560114	RES,FILM,1/4W,49.9K,1%	RN60C4992F	81349	1.0
R107	510068	RES,CARB,1/4W,4.7K OHM	RC07GF472J	81349	1.0
R108	510021	RES,CARB,1/4W,47 OHM	RC07GF470J	81349	1.0
R109	510046	RES,CARB,1/4W,510 OHM	RC07GF511J	81349	1.0
R110	550008	RES,PWR,3W,5.1 OHM,1%	RS-2B-5.1 OHM	91637	1.0
R111	550010	RES,PWR,3W,.5 OHM,3%	RS-2B-.5 OHM	91637	1.0
R112	550010	RES,PWR,3W,.5 OHM,3%	RS-2B-.5 OHM	91637	1.0
R113	550010	RES,PWR,3W,.5 OHM,3%	RS-2B-.5 OHM	91637	1.0
R114	550010	RES,PWR,3W,.5 OHM,3%	RS-2B-.5 OHM	91637	1.0
R115	550010	RES,PWR,3W,.5 OHM,3%	RS-2B-.5 OHM	91637	1.0
R117	510025	RES,CARB,1/4W,68 OHM	RC07GF680J	81349	1.0
R118	550008	RES,PWR,3W,5.1 OHM,1%	RS-2B-5.1 OHM	91637	1.0
R119	510046	RES,CARB,1/4W,510 OHM	RC07GF511J	81349	1.0
R120	550010	RES,PWR,3W,.5 OHM,3%	RS-2B-.5 OHM	91637	1.0
R121	550010	RES,PWR,3W,.5 OHM,3%	RS-2B-.5 OHM	91637	1.0
R122	550010	RES,PWR,3W,.5 OHM,3%	RS-2B-.5 OHM	91637	1.0
R123	550010	RES,PWR,3W,.5 OHM,3%	RS-2B-.5 OHM	91637	1.0
R124	550010	RES,PWR,3W,.5 OHM,3%	RS-2B-.5 OHM	91637	1.0
R125	510104	RES,CARB,1/4W,150K OHM	RC07GF154J	81349	1.0
R126	510104	RES,CARB,1/4W,150K OHM	RC07GF154J	81349	1.0
R127	510100	RES,CARB,1/4W,100K OHM	RC07GF104J	81349	1.0
R128	510100	RES,CARB,1/4W,100K OHM	RC07GF104J	81349	1.0
R129	510104	RES,CARB,1/4W,150K OHM	RC07GF154J	81349	1.0
R130	560532	RES,FILM,1/4W,127K,1%	RN60C1273F	81349	1.0

SEQ NO.	COMPONENT ITEM NO.	DESCRIPTION TRUNCATED	ENGINEERING DRAWING NO.	VENDOR	QTY	U
R131	510021	RES,CARB,1/4W,47 OHM	RC07GF470J	81349	1.0	E
R132	510059	RES,CARB,1/4W,2.0K OHM	RC07GF202J	81349	1.0	E
R133	510076	RES,CARB,1/4W,10K OHM	RC07GF103J	81349	1.0	E
R134	570156	POT,1T,PC,5K,1/4W	X201R502B	71450	1.0	E
R135	510049	RES,CARB,1/4W,680 OHM	RC07GF681J	81349	1.0	E
R136	510076	RES,CARB,1/4W,10K OHM	RC07GF103J	81349	1.0	E
R137	550202	RES,PWR,3-1/4W,160 OHM,5%	4397	44655	1.0	E
R138	510069	RES,CARB,1/4W,5.1K OHM	RC07GF512J	81349	1.0	E
R139	510126	RES,CARB,1/4W,2.2M OHM	RC07GF225J	81349	1.0	E
R140	570157	POT,1T,PC,100K,1/4W	X201R104B	71450	1.0	E
R141	510135	RES,CARB,1/4W,10M OHM	RC07GF106J	81349	1.0	E
S1	240450	SWITCH,RTRY	1120-011-1	16067	1.0	E
4	160203	PWB,AMPLIFIER	1120-700-7	16067	1.0	E
5	250076	TERMINAL,TURRET,SOLID	20108-1	88245	9.0	E
274	210709	INSULATOR,HEATSINK	1120-223-7	16067	2.0	E
275	210710	INSULATOR,MOUNT,HEATSINK	1120-224-7	16067	2.0	E
276	210518	INSULATOR,MOUNT,HEATSINK	1120-204-7	16067	1.0	E
277	210502	HEATSINK	1120-206-7	16067	2.0	E
279	210499	HEATSINK	6025D	13103	2.0	E
280	210384	HEATSINK,DO10	UP-T015-IRIDITE	98978	1.0	E
281	210711	FSTNR,RVT,POP,1/8X.634	AD48ABS	07707	8.0	E
283	240296	SOCKET,XSTR,TO-5	RCT05075-7A	19080	6.0	E
284	110279	BRACKET,ANGLE	MS9595-015	18076	1.0	E
285	110472	BRACKET,ANGLE	MS9596-026	18076	1.0	E
286	110167	BRACKET,ANGLE	129515	73734	1.0	E
291	FS1014	SCREW,FLH,S/S,4-40X1/4	MS24693-C2	96906	12.0	E
292	FS1011	SCREW,PNH,S/S,4-40X1/4	MS51957-13	96906	4.0	E
293	FS1006	SCREW,PNH,S/S,4-40X5/16	MS51957-14	96906	1.0	E
294	FS1068	WASHER,INTER,S/S,#4	MS35333-70	81349	4.0	E
296	FS1066	NUT,HEX,S/S,4-40	MS35649-244	96906	2.0	E
300	FS1026	SCREW,PNH,S/S,6-32X1/4	MS51957-26	96906	12.0	E
302	FS1034	SCREW,PNH,S/S,6-32X5/8	MS51957-31	96906	12.0	E
305	FS1069	WASHER,INTER,S/S,#6	MS35333-71	96906	24.0	E
306	FS1080	WASHER,FLAT,S/S,#6	MS15795-806	96906	1.0	E
307	FS1064	NUT,HEX,S/S,6-32	MS35649-264	96906	12.0	E
310	FS5119	WIRE,BUS,AWG 22,QQ-W-343E	QQW343S22S2B	81348	2.0	E
311	FS5122	WIRE,BUS,AWG 16,QQ-W-343E	QQW343S16S2B	81348	2.0	E
312	FS6009	TUBING,TEFLON,AWG 22	TFT-200-22-NAT.	92194	2.0	E
313	FS4001	THERMAL COMPOUND	351	13103	.2	E
316	FS1056	SCREW,PNH,S/S,10-32X3/8	MS51958-61	81349	2.0	E
317	FS1071	WASHER,INTER,S/S,#10	MS35333-73	96906	2.0	E
318	FS1067	NUT,HEX,S/S,10-32	MS35650-304	96906	2.0	E

PARENT ITEM NO. 1120-704-1 DESCRIPTION PC ASSY,OVERVOLT PROT ENGR DRAW 1120-704 REV D3

SEQ NO.	COMPONENT ITEM NO.	DESCRIPTION TRUNCATED	ENGINEERING DRAWING NUMBER	VENDOR	QTY	UM
BR1	310254	BRDG,RECT,FW,1A,200V,DIP	VM28	27683	1.0	EA
CR1	310227	DIODE,SWNG,75V,.5W,DO35	1N4148	07263	1.0	EA
CR2	310227	DIODE,SWNG,75V,.5W,DO35	1N4148	07263	1.0	EA
CR3	310227	DIODE,SWNG,75V,.5W,DO35	1N4148	07263	1.0	EA
CR4	310227	DIODE,SWNG,75V,.5W,DO35	1N4148	07263	1.0	EA
CR5	310227	DIODE,SWNG,75V,.5W,DO35	1N4148	07263	1.0	EA
C1	610746	CAP,TANT,22UF,25V	T362C226M025AS	05397	1.0	EA
C2	610746	CAP,TANT,22UF,25V	T362C226M025AS	05397	1.0	EA
C3	610746	CAP,TANT,22UF,25V	T362C226M025AS	05397	1.0	EA
C4	610746	CAP,TANT,22UF,25V	T362C226M025AS	05397	1.0	EA
C5	610721	CAP,MYLAR,1UF,100V	112A1B105M	14752	1.0	EA
C6	610804	CAP,TANT,33UF,35V	T362D336M035AS	05397	1.0	EA
C7	610802	CAP,TANT,4.7UF,25V	T362B475M025AS	05397	1.0	EA
C8	610877	CAP,TANT,47UF,15V	T362C476M015AS	05397	1.0	EA
C9	610781	CAP,TANT,.47UF,50V	T362A474M050AS	05397	1.0	EA
C10	610781	CAP,TANT,.47UF,50V	T362A474M050AS	05397	1.0	EA
C11	611007	CAP,CER,.1UF,25V	TCA-104Z	02799	1.0	EA
C12	611007	CAP,CER,.1UF,25V	TCA-104Z	02799	1.0	EA
C13	610746	CAP,TANT,22UF,25V	T362C226M025AS	05397	1.0	EA
C14	610746	CAP,TANT,22UF,25V	T362C226M025AS	05397	1.0	EA
C15	611007	CAP,CER,.1UF,25V	TCA-104Z	02799	1.0	EA
C16	610761	CAP,TANT,1UF,20V	T362A105M020AS	05397	1.0	EA
C17	610746	CAP,TANT,22UF,25V	T362C226M025AS	05397	1.0	EA
J1	410287	CONN,PC HDR,12 PIN	09-72-1121	27264	1.0	EA
K1	245157	RELAY,CRADLE,4C,2A,24V	ITT25A04C18E	15238	1.0	EA
Q1	330284	TRANSISTOR,SS,NPN,TO92	PN2222A	07263	1.0	EA
Q2	330284	TRANSISTOR,SS,NPN,TO92	PN2222A	07263	1.0	EA
R2	560079	RES,FILM,1/4W,10K,1%	RN60D1002F	81349	1.0	EA
R3	560115	RES,FILM,1/4W,49.9K,1%	RN60D4992F	81349	1.0	EA
R4	560399	RES,FILM,1/4W,66.5K,1%	RN60C6652F	81349	1.0	EA
R5	560115	RES,FILM,1/4W,49.9K,1%	RN60D4992F	81349	1.0	EA
R6	570183	POT,MT,PC,10K,1/4W,20%	ET34X103	30983	1.0	EA
R7	560067	RES,FILM,1/4W,7.5K,1%	RN60D7501F	81349	1.0	EA
R8	560067	RES,FILM,1/4W,7.5K,1%	RN60D7501F	81349	1.0	EA
R9	510063	RES,CARB,1/4W,3.0K OHM	RC07GF302J	81349	1.0	EA
R1A	550233	RES,PWR,5W,20K OHM	995-4661	44655	1.0	EA
R1B	550233	RES,PWR,5W,20K OHM	995-4661	44655	1.0	EA
R10	570132	POT,MT,PC,5K,1/4W,20%	ET34X502	30983	1.0	EA
R11	570132	POT,MT,PC,5K,1/4W,20%	ET34X502	30983	1.0	EA
R12	510053	RES,CARB,1/4W,1K OHM	RC07GF102J	81349	1.0	EA
R13	510084	RES,CARB,1/4W,22K OHM	RC07GF223J	81349	1.0	EA
R14	510084	RES,CARB,1/4W,22K OHM	RC07GF223J	81349	1.0	EA
R15	510084	RES,CARB,1/4W,22K OHM	RC07GF223J	81349	1.0	EA
R16	510092	RES,CARB,1/4W,47K OHM	RC07GF473J	81349	1.0	EA
R17	510084	RES,CARB,1/4W,22K OHM	RC07GF223J	81349	1.0	EA
R18	510084	RES,CARB,1/4W,22K OHM	RC07GF223J	81349	1.0	EA
T1	710340	TRANSFORMER	DPC16-55	08779	1.0	EA
U1	360268	IC,VOLTAGE REG,+15,.1A	MC78L15ACP	04713	1.0	EA
U2	360269	IC,VOLTAGE REG,-15,.1A	MC79L15ACP	04713	1.0	EA
U3	360030	IC,OP-AMP,GP,COMPENSATED	LM741CN	27014	1.0	EA
U4	360219	IC,COMPARATOR,DUAL	LM393N	27014	1.0	EA

PARENT ITEM NO. 1120-704-1

DESCRIPTION PC ASSY,OVERVOLT PROT
ENGR DRAW 1120-704 REV D3

SEQ NO.	COMPONENT ITEM NO.	DESCRIPTION TRUNCATED	ENGINEERING DRAWING NUMBER	VENDOR	QTY
W2	FS5004	WIRE,BU,MIL-W-16878/4	AWG 24,WHT	81349	2.0
W3	FS5004	WIRE,BU,MIL-W-16878/4	AWG 24,WHT	81349	2.0
5	1C0324	PWB,OVERVOLTAGE PROTECT	1120-704-7	16067	1.0

Appendix A

Number	Vendor Name	City	State
0000A	Electricord	Westfield	PA
0000C	Jackson Bros.	Waddon,Surrey	GB
0000S(28564)	OPCDA (Refac Elect. Corp.)	Winsted	CT
0000W	Milton Roes Co.	Southampton	PA
0000Z(52745)	Timco	Los Angeles	CA
000AC	Itac	Santa Clara	CA
000AD(55112)	Plessey (Westlake Cap. Inc.)	Westlake Village	CA
000AG	Lafrance	Philadelphia	PA
000AH(54363)	Jan Crystal	Ft. Myers	CA
000AL(53495)	Data Components, Inc.	Gardena	CA
000AM	Kraus & Naimer	Santa Monica	CA
000AN	Ritz Instrument Transformer	Redondo Beach	CA
000AS	Switches Incorporated	Mt. View	CA
000AT(62643)	United Chemi-Con	Rosemont	IL
000AU	JMJ Technical Prod. Inc.	Kendall Park	NJ
000AV(61837)	Semi Processes, Inc.	San Jose	CA
000AW	Hirose	Chatsworth	CA
000AX(63878)	Aptronics	Mentor	OH
000AY	Silicon Power Cube Corp.	Long Beach	CA
000AZ(61271)	Fujitsu	Santa Clara	CA
000BA(61964)	Omron Electronics, Inc.	Schaumburg	IL
000BB	Hallmark Metals, Inc.	Glendora	CA
000BC	Toshiba America, Inc.	Tustin	CA
000BD(55982)	Electronic Essentials	Woodside	NY
000BE(57856)	Kel-Am	Eldon	MO
000BF(55285)	Berquist	Minneapolis	MN
000BG	Panasonic	Secaucus	NY
000BH	Century Components	Canyon Country	CA
000BI(54186)	Micro Power Systems	Santa Clara	CA
000BJ(06776)	Robinson Nugent	New Albany	IN
000BL(13150)	Beau Products (Vernitron)	Laconia	NH
000BM(917723)	Corebinder (Gerrard AJ & Co.)	Des Plaines	IL
000BO	Mitsubishi Electronics Amer.	Sunnyvale	CA
000BP	Silicon Power Cube	Long Beach	CA
000BR	Secmo	Bagnolet	France
000BS	Panel Components Corp.	Santa Rosa	CA
00544	Metal-Cal Div., Avery Prod.	Inglewood	CA
00779	AMP Inc.	Harrisburg	PA
00853	Sangamo Electronic Co.	Pickens	SC
00866	Goe Eng. Co., Inc.	City of Industry	CA
01002	G.E. Co., Ind. & Pwr. Cap. Dept.	John St. Hudson Falls	NY
01121	Allen-Bradley Co.	Milwaukee	WI
01139	G.E. Co., Silicone Prod.	Waterford	NY
01295	Texas Instruments	Dallas	TX
01961	Pulse Engineering, Inc.	San Diego	CA
02111	Spectrol Electronics	City of Industry	CA
02113	Coilcraft, Inc.	Cary	IL
02335	Fairchild Controls Corp.	Hicksville,LI	NY
02375	American Insulating Mach. Co.	Philadelphia	PA
02538	Texas Electronics Co.	Dallas	TX
02660	Amphenol Corporation	Broadview	IL
02768	Illinois Tool Works, Inc.	Des Plains	IL
02799	Use Code 172136		
03507	General Electric Company	Syracuse	NY
03508	General Electric Company	Syracuse	NY
03797	Eldema Corporation	Compton	CA
03888	Pyrofilm Resistor Co., Inc.	Cedar Knolls	NJ
03911	Claircx Corporation	New York	NY
04009	Arrow-Hart and Hegeman Elec.	Hartford	CT
04099	Capco, Inc.	Grand Junction	CO
04713	Motorola Semiconductor Prod.	Phoenix	AZ
04729	Universal Components Corp.	Green Brook	NJ
04963	3-M	St. Paul	MN
05245	Corcom Inc.	Chicago	IL
05276	Pomona Electronics., Inc.	Pomona	CA
05397	Kemet, Union Carbide Corp.	Cleveland	OH
05791	Lyn-Tron, Inc.	Burbank	CA
05820	Wakefield Engineering, Inc.	Wakefield	MA
05972	Loctite Corp.	Newington	CT
06383	Panduit Corp.	Tinley Park	IL
06514	Stanctron, Wyco Metal Prod.	N. Hollywood	CA
06540	Amaton Elect. Hardware	New Rochelle	NY
06665	Precision Monolithics Inc.	Santa Clara	CA
06776	Robinson Nugent, Inc.	New Albany	IN
06815	Richco Plastics, Co.	Chicago	IL
07088	Kelvin Electric Company	Van Nuys	CA
07263	Fairchild Camera & Instr.	Mt. View	CA
07387	Birtcher Corporation	Los Angeles	CA
07556	Unitrack Calabro Plastics	Upper Darby	PA
07633	Epoxy Prod. Co., Allied Prod. Corp.	New Haven	CT
07707	USM Corp. (USM Fastener Div)	Shelton	CT
07716	IRC Incorporated	Burrington	IA
07910	Use Code 415818		
08028	Loctite (Auto & Consumer Grp)	Mtn View	CA
08057	Spang Ind. (Magnetics Div)	Sandy Lake	PA
08065	Accurate Rubber and Plastics	San Diego	CA
08261	Spectra Strip (Amphenol)	Garden Grove	
08289	Allen Deibert Co.	Pomona	CA
08353	Bristol Co. of Canada	Toronato, Ont	Canada
08730	Ostby & Barton (Vomaline Prod. Div.)	Warwick	RI
08779	Signal Transformer	Brooklyn	NY
09214	GE (Semiconductor Prod. Div)	Auburn	NY
09353	C & K Components	Newton	MA
09922	Burndy Corp.	Norwack	CT
10389	Chicago Switch	Chicago	IL
11815	Cherry/Textron (Fastener Div)	Santa Ana	CA
12406	Elpac Electronics	Santa Ana	CA
12697	Clarostat Mfg.	Dover	NH
13103	Thermalloy Company	Dallas	TX
13150	Vernitron Corp (Beau Prod.)	Laconia	NH
13404	Sperry Corp. Elec. Systems	Great Neck	NY
13919	Burr-Brown	Tucson	AZ
14099	Semtech Corporation	Newbury Park	CA
14604	Elmwood Sensors Inc.	Cranston	RI
14655	Cornell-Dubilier Elect. Corp.	Newark	NJ
14726	Hollingsworth Co.	Phoenixville	PA
14752	Electro Cube, Inc.	San Gabriel	CA
14908	Electronic Instrument and Specialty Corp.	Stoneham	MA
15238	ITT Semiconductors	Lawrence	MA
15454	Ametek EMA (Rodan Div)	Anaheim	CA
15636	Elec-trol	Northridge	CA
15801	Fenwall Electronics	Framingham	MA
15818	Amelco Teledyne, Inc.	Mt. View	CA
15912	Analex	Los Angeles	CA
16067	California Instruments Co.	San Diego	CA
16758	Delco Radio Div., Gen. Mtrs.	Kokomo	IN
16956	Dennison	Framingham	MS
17856	Siliconix, Inc.	Santa Clara	CA
18076	Umpco	City of Industry	CA
18178	Vactec, Inc.	Maryland Heights	MO
18310	Concord Electronics Corp.	New York	NY
18324	Signetics	Sunnyvale	CA
18612	Vishay Instruments, Inc.	Malvern	PA
18677	Scamco Mfg. Co. (Iero Corp.)	Monterey Park	CA
18722	RCA	Mountaintop	PA
18736	Voltronics Corp.	Hanover	NJ
19080	Robison Company	Hawthorne	CA
21604	Buckeye Stamping Company	Columous	OH
21845	Solitron Devices (Semi-conductor Group)	Riviera Beach	FL
22599	Elastic Stop Nut Corp.	Van Nuys	CA
23050	Product Components Corp.	Hastings-on-Hudson	NY
23936	Pamotor, Inc.	San Francisco	CA
24011	ECC	Burlington	MA
24355	Analog Devices, Inc.	Norwood	MA
24444	General Semiconductor Inc.	Tempe	AZ
24796	Paraico, Inc.	Paramount	CA
24931	Specialty Connector Co., Inc.	Greenwood	IN
24972	AEG-Telefunken Corp.	Summerville	NJ
25403	Amperex Electronic Corp.	Slatersville	RI
25497	Meter Master	Los Angeles	CA
26405	Marathon Electric Mfg. Corp.	Bowling Green	OH
26806	American Tattler, Inc.	Costa Mesa	CA
27014	National Semi-Conductor Crp.	Santa Clara	CA
27191	Cutler-Hammer, Inc.	Milwaukee	WI
27264	Molex	Downers Grove	IL
27335	B & B Motor & Control Corp.	New York	NY
27556	IMB Electronic Products	Santa Fe Springs	CA
27683	Varo, Inc.	St. Garland	TX
27735	F-Dyne Electronics	Bridgeport	CT
27832	Hughes Aircraft	Newport Beach	CA
28480	Hewlett-Packard Co.	Palo Alto	CA
28520	Heyman Mfg. Company (Heyco)	Kenilworth	NJ
28606	Echlin Ltd.	Rexdale Ont.	Canada
29372	Rexnord Inc. Tridair Ind.	Torrance	CA
29593	Bussco Eng., Inc.	El Segundo	CA
30039	International Components Crp.	Asbury Park	NJ
30161	Asvid Engineering, Inc.	Laconia	NH
30897	Dozann Company	Sylmar	CA
30983	Electra/Midland (Mepco/ Electra)	San Diego	CA
31827	Budwig Mfg. Co.	Ramona	CA
31951	Triridge, Inc.	Pittsburg	PA
32293	Intersil	Cupertino	CA
32559	Bivar, Inc.	Santa Ana	CA
32997	Bourns Inc. (Trimpot Div)	Riverside	CA
33005	Jewell Electrical Inst. Inc.	Manchester	NH
33135	Logic Dynamics, Inc.	Gardena	CA
33716	Kingsbacher, Murray Co.	Los Angeles	CA
33855	Ducommun, Inc.	Los Angeles	CA
33901	Colber Corp.	Irvington	NJ
34238	Mills Resistor Co.	Los Alamitos	CA
34333	Silicon General	Westminster	CA
34649	Intel Corporation	Santa Clara	CA
35007	Aerovox Canada Ltd.	Amherst NS	Canada
37964	Lineac Technology, Inc.	Burlington, Ont	CAN
44655	Okmite Manufacturing Co.	Skokie	IL
45722	Parker-Kalon	Clifton	NJ
46384	Penn. Eng. and Mfg. Corp.	Doylestown	PA
50157	Midwest Components, Inc.	Muskegon	MI
50522	Monsanto, Electronic Special Products	Cupertino	CA
50558	Electronic Concepts, Inc.	Eatontown	NJ
50811	Mouser Corp.	Santee	CA
51167	Aries Electronics, Inc.	Frenchtown	NJ
51506	Accurate Screw Machine Co.	Mutley	NJ
51705	ICO/Rally	Palo Alto	CA
52072	Circuit Assembly Corp.	Costa Mesa	CA
52745	Timco	Los Angeles	CA
53076	Kintex, Inc.	Buffalo	NY
53495	Data Components, Inc.	Gardena	CA
54361	Edwards Sheet Metal Works	Fredericktown	OH
54407	Power-One Co.	Camarillo	CA
55122	Samtek, Inc.	New Albany	NY
55566	RAF Electronic Hardware, Inc.	Seymour	CT
56289	Sprague Electric Company	North Adams	MA
56637	RCD Components, Inc.	Manchester	NH
57640	United Chem-Con Corp.	Philadelphia	PA
57856	Kel-Am, Inc.	Eldon	MO
58474	Superior Electric Company	Bristol	CT
59730	Thomas and Betts Company	Elizabeth	NJ
59993	International Rectifier Semiconductor Div.	El Segundo	CA
60395	Xicor, Inc.	Milditas	CA
61394	Seeq Technology, Inc.	San Jose	CA
61441	Saronix	Palo Alto	CA
61529	Aromat Corp.	Mountainside	NJ
61735	Pulse Engineering, Inc.	College Park	MD
62483	Dentitron Corp. of America	Torrance	CA
62643	United Chemicon, Inc.	Rosemont	IL
62786	Hitachi America Ltd.	San Jose	CA
63743	Ward Leonard Electric Co.	Mt. Vernon	NY
63791	Star Micronics, Inc.	New York	NY
70318	Allmetal Screw Prod. Co.	Garden City	NY
70903	Belden Manufacturing Co.	Chicago	IL
71218	Bud Industries, Inc.	Willoughby	OH
71279	Cambridge Thermionic Corp.	Cambridge	MA
71400	Bussmann Mfg. Div. McGraw-Edison Co.	St. Louis	MO
71450	CTS Corporation	Elkhart	IN
71468	ITT Cannon Electric, Inc.	Los Angeles	CA
71590	Centralab Div. Globe-Union	Milwaukee	WI
71707	Coto-Coil	Providence	RI
71744	Chicago Miniature Lampworks	Chicago	IL
71785	Cinch Manufacturing Company	Chicago	IL
71984	Dow Corning Corp.	Midland	MI
72136	Elmenco (Electro Motive)	Willimantic	CT
72619	Dialight Corporation	Brooklyn	NY
72699	General Instruments	Newark	NJ
72982	Erie Technological Prod. Inc.	Erie	PA
73138	Beckman Instruments, Inc.	Fullerton	CA
73612	Consolidated Electronic Wire and Cable Corp.	Chicago	IL
73734	Federal Screw Products, Inc.	Chicago	IL
74193	Heinemann Electric Company	Trenton	NJ
74545	Harvey Hubbell, Inc.	Bridgeport	CT
74840	Illinois Condenser Co.	Chicago	IL
74970	E.F. Johnson Company	Waseca	MN
75042	TRW Electronic Components	Philadelphia	PA
75382	Kulka Electric Corporation	Mt. Vernon	NY
75582	Leviton Mfg. Co.	Little Neck	NY
75915	Littlefuse, Inc.	Des Plaines	IL
76385	Minor Rubber Co., Inc.	Bloomfield	NJ
77062	Pabac Eng. Equipment Co.	Elizabeth	NJ
77132	United-Carr Inc., Fastvin Div	Watertury	CT
77342	Potter and Blumfield Div, AMF	E. Princeton	IN
78189	Shakeproof Div, IL Tool Works	Chicago	IL
78553	Tinnerman Products, Inc.	Cleveland	OH
79139	Johns-Manville Products Corp	Chicago	IL
79136	Waldes Kohinoor Inc.	Long Island City	NY
79963	Zierick Mfg. Corp.	New Rochelle	NY
80031	Mepco/Electra	Morristown	NJ
80223	United Transformer Co.	New York	NY
80294	Bourns, Inc.	Riverside	CA
80495	High Voltage Engineering Corp (Anderson Pwr Prod. Div)	Brigston	MA
81095	Triad Transformer Corp.	Venice	CA
81312	Winchester Electronics	Oakville	CT
81348	(Fed. Specs) Promulgated by General Services Administration Washington DC		
81349	Military Specification or Commercial Generic Number		
81541	Airpax Corp.	Cambridge	MD
81603	Reco Products Co.	Chicago	IL
81851	Bentley-Harris Mfg Co.	Lionville	PA
82104	Standard Grigsby	Aurora	IL
82389	Switchcraft, Inc.	Chicago	IL
82877	Rotron Mfg. Co., Inc.	Woodstock	NY
82893	Vector Electronics, Inc.	Sylmar	CA
83330	Herman H. Smith, Inc.	Brooklyn	NY
83486	Elco Tool & Screw Corp.	Rockford	IL
85480	Brady W.H. Co.	Milwaukee	WI
86684	RCA	Harrison	NJ
86928	Seastrom Mfg. Co., Inc.	Glendale	CA
87034	Marco-Oak Industries	Anaheim	CA
88245	Useco Div., Litton Ind.	Van Nuys	CA
90201	Mallory Capacitor Co.	Indianapolis	IN
91506	Augat, Inc.	Attleboro	MA
91637	Dale Electronics, Inc.	Columbus	NE
91662	Elco Corporation	Willow Grove	PA
91802	Industrial Devices, Inc.	Edgewater	NJ
91833	Keystone Electronics Corp.	New York	NY
91967	National Tel-Tronics	Meadville	PA
92194	Alpha Wire Corp.	Elizabeth	NJ
93303	Pentagon Products Co.	Washington	DC
94222	Southco, Inc.	Lester	PA
94696	Magnecraft Electric Co.	Chicago	IL
95146	Alco Electronic Prod., Inc.	No. Andover	MA
95303	RCA	Cincinnati	OH
95354	Methode Manufacturing Corp.	Rolling Meadows	IL
95566	Arnold Engineering Co.	Marengo	IL
95987	Weckesser Company, Inc.	Chicago	IL
96906	Military Std		
97525	Electronic Engineering Co.	Santa Ana	CA
98159	Rubber Tech, Inc.	Gardena	CA
98291	Sealetto Corp.	Mamaroneck	NY
98376	Iero Mfg. Co. (West)	Burbank	CA
98978	IERC	Burbank	CA
99017	Protective Closures Co., Inc. (Caplugs Div)	Buffalo	NY
99217	Bell Industries, Inc.	Delavan	WI
99742	Permacell	New Brunswick	NJ
99743	IMC	Maywood	CA
99800	Delevan Electronics Corp.	Aurora	NY

Revision K
June 17, 1986

ONE YEAR WARRANTY

CALIFORNIA INSTRUMENTS, Division of Amstar Technical Products Co., Inc., warrants each instrument manufactured by them to be free from defects in material and workmanship for a period of one year from the date of shipment to the original purchaser. Excepted from this warranty are tubes, fuses, and batteries which carry the warranty of their original manufacturer where applicable. CALIFORNIA INSTRUMENTS will service, replace, or adjust any defective part or parts, free of charge, when the instrument is returned freight prepaid, and when examination reveals that the fault has not occurred because of misuse, abnormal conditions of operation, user modification, or attempted user repair. Equipment repaired beyond the effective date of warranty or when abnormal usage has occurred will be charged at applicable rates. CALIFORNIA INSTRUMENTS will submit an estimate for such charges before commencing repair, if so requested.

PROCEDURE FOR SERVICE

If a fault develops, notify CALIFORNIA INSTRUMENTS or its local representative, giving full details of the difficulty, and including the model number and serial number. On receipt of this information, service data or a Return Material Authorization (RMA) number will be given. Fill in RMA No. blank on shipping label attached opposite these instructions, pack instrument carefully to prevent transportation damage, affix label to shipping container, and ship freight prepaid to the factory. CALIFORNIA INSTRUMENTS shall not be responsible for repair of damage due to improper handling or packing. Instruments returned without RMA No., or freight collect will be refused. Instruments repaired under Warranty will be returned by prepaid surface freight. Instruments repaired outside the Warranty period will be returned freight collect, F.O.B. CALIFORNIA INSTRUMENTS, San Diego, CA. If requested, an estimate of repair charges will be made before work begins on repairs not covered by the Warranty.

DAMAGE IN TRANSIT

The instrument should be tested as soon as it is received. If it fails to operate properly, or is damaged in any way, a claim should be filed immediately with the carrier. A full report of the damage should be obtained by the claim agent, and a copy of this report should be forwarded to us. CALIFORNIA INSTRUMENTS will prepare an estimate of repair cost, and repair the instrument when authorized by the claim agent. Please include model number and serial number when referring to the instrument.

From

Amstar
Electronics Group

California Instruments Corporation

5150 Convoy Street
San Diego, California 92111

Attn: Customer Service

RMA NO. _____

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